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V. CONTRIBUTION À L'ÉTUDE DU GENRE *HALICYCLOPS* NORMAN.

Par KNUT LINDBERG.

Halicyclops canui, sp. nov.

Description. -Longueur 845 μ; céphalothorax 598 μ, queue (abdomen+furca sans soies apicales) 247 μ; largeur 313 μ; longueur du premier segment céphalothoracique 294 μ. Segment génital se rétrécissant très légèrement du côté distal; les parties latérales présentent vers le milieu du segment une protubérance assez marquée. Bord postérieur du troisième segment abdominal découpé sur la face dorsale en petites dents indistinctes. Segment anal profondément divisé. Branches de la furca parallèles, moins de 1·5 fois aussi longues que larges (33 : 23μ =1·43 : 1). Soie latérale externe divisant la branche de la furca dans la proportion 16 : 17. Soie dorsale assez longue (50 μ), surpassant

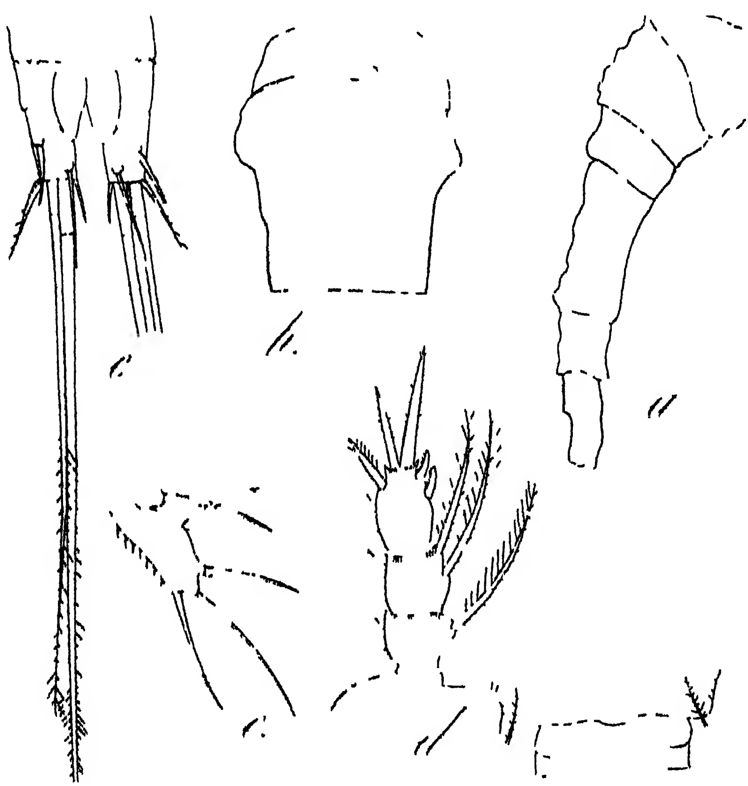

Fig. 1. *Halicyclops canui*, sp. nov. ♀.
a. Première antenne; *b.* Segment génital; *c.* Furca, face dorsale; *d.* Enp. 4 et lamelle basale; *e.* P 5.

légèrement la longueur de la soie apicale externe. Celle-ci deux fois plus longue que la soie apicale interne. Soie apicale médiane externe

moins que la moitié de la longueur de la soie apicale médiane interne. Les deux soies apicales médianes ne portent que des cils, dont la disposition est représentée sur la figure. Longueurs respectives des soies apicales 45 : 234 : 529 : 22 μ. Première antenne à 6 articles. Branches des pattes natatoires triarticulées. Formule des épines 2·3·3·3 Article 3 de l'enp. 4 moins que deux fois aussi long que large (45 : 24 μ =1·87 : 1). Epine apicale interne dépassant en longueur aussi bien celle de l'épine apicale externe que celle de l'article. Epine apicale interne : épine apicale externe 67 : 47 μ = 1·43 : 1 ; épine apicale interne : article 67 : 45 μ = 1·49 : 1. Epine du rebord externe de l'article terminal de l'enp. 4 de structure normale : les deux soies du rebord interne de cet article transformées en deux petites épines obtuses, portant des cils gros et courts. Lamelle basale de la quatrième paire de pattes offrant un aspect particulier, étant très élargie mais de faible hauteur. Le premier article de la cinquième patte ne forme qu'une protubérance soudée au segment thoracique, portant une longue soie, et ne présente rien de distinctif. Le deuxième article montre l'aspect décrit par Sewell chez *H. tenuispina*. c'est-à-dire les 3 épines sont très allongées et amincies et peu différentes de la soie. Le réceptacle séminal n'a pas pu être distingué. Ovisacs allongés, dépassant l'extrémité de la furca, étroitement appliqués contre l'abdomen. Ils contenaient chacun 13 oeufs. Mâle inconnu.

Habitat.—Les marais à Bandra mentionnés au sujet de l'espèce suivante. Une seule femelle récoltée au mois d'octobre.

Remarques.—L'espèce qui vient d'être décrite se rapproche de *H. tenuispina* découvert dans le lac Tchilka sur la côte Nord-Est de l'Inde. A part des épines effilées de P 5 l'espèce de Sewell montre une modification curieuse des épines marginales des exopodites des pattes natatoires, ces épines ayant un aspect en massue, particularité que ne présente pas la forme dont il s'agit ici. De plus, d'après le texte de Sewell, la formule des épines de *H. tenuispina* est de 4·4·4·3 (la figure de l'exopodite de P 4 montre cependant 4 épines). Par suite de ces différences importantes il est nécessaire de considérer l'animal de Bandra comme représentant une espèce nouvelle. Je l'ai nommé en souvenir de l'auteur des "Copépodes du Boulonnais", E. Canu.

Halicyclops thermophilus spinifer Kiefer.

Description.—Longueur de la femelle ovigère de 589 μ à 784 μ (moyenne, animaux de l'Inde 688 μ, ceux de l'Iran 661 μ) ; largeur de 224 μ à 285 μ (moyennes 258 μ et 234 μ respectivement). Segment génital présentant latéralement vers le milieu, à la limite de fusion des deux segments originaux, une forte épine chitineuse, dirigée vers le bas. Bords postérieurs des segments abdominaux découpés sur la face dorsale en petites dents plus ou moins distinctes. Ces dents sont sur le milieu du rebord postérieur du troisième segment abdominal considérablement plus grandes que sur les parties latérales du même segment. Chez quelques animaux je n'ai pourtant pas pu distinguer cette dentelure. Segment anal profondément fendu, divisé presque en deux moitiés. Le bord postérieur de ce segment porte sur la face ventrale une rangée de petites épines. Bord libre de l'opercule anal

lisse ; chez un seul animal il était pourvu de spinules extrêmement petites. Dans l'échancrure anale on distingue parfois des rangées de petites dents minuscules. Branches de la furca un peu plus longues que larges, le rapport variant de 1·15 : 1 à 1·50 : 1 avec une moyenne de 1·33 : 1 chez les animaux de Bombay et de 1·39 : 1 chez ceux du golfe Iranien. Elles sont le plus souvent fortement divergentes mais peuvent aussi être parallèles, même chez des femelles adultes, étant sans doute mobiles. Soie latérale externe forte mais courte, insérée en général en avant du milieu de la branche de la furca et rarement au milieu même.

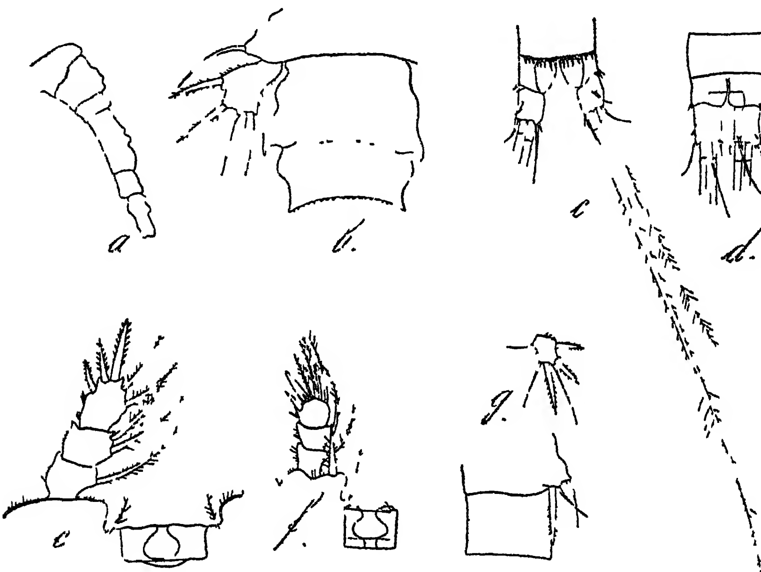

Fig. 2. *Halicyclops thermophilus spinifer* Kiefer. Spécimens de Bandra.
a. ♀ Première antenne ; *b.* ♀ P 5 et segment génital ; *c.* ♀ Furca, aspect dorsal ; *d.* ♀Furca autre spécimen ; *e.* ♀Enp. 4 et lamelle basale ; *f.* ♀ Enp. 1 et lamelle basale; *g.* ♂ P 5 et P 6.

Soie dorsale assez longue, prenant origine sur une petite protubérance qui ne dépasse pas l'extrémité de la branche de la furca. Soie apicale externe assez bien développée, environ deux fois aussi longue que la soie apicale interne. Chez les spécimens indiens leur rapport de longueur moyenne était de 1·94 : 1 ; chez ceux de l'Iran la soie apicale externe était plus de deux fois aussi longue que la soie apicale interne (rapport 2·18 : 1). Soie apicale médiane interne moins que deux fois aussi longue que la soie apicale médiane externe ; leur pennation est hétéronyme et se voit sur les figures. Première antenne courte composée de 6 articles. Pattes natatoires tri-articulées. La soie située sur la base de la première paire de pattes a l'aspect d'une forte épine portant de longs cils. Formule des épines 3·4·4·3. Article terminal de l'endopodite de P 4 environ 1·5 fois aussi long que large (rapport moyen 1·49 : 1 pour les animaux de l' Inde et 1·57 : 1 pour ceux de l'Iran). Epine apicale interne plus longue que l'article et considérablement plus longue que l'épine apicale externe ; rapport moyen épine interne : épine externe 1·42 : 1 (Inde), 1·34 : 1 (Iran) ; rapport épine interne : article

1·29 : 1 et 1·17 : 1 respectivement. Epine du rebord externe du même article un peu moins longue que l'épine apicale externe ; les deux soies du rebord interne sont de structure normale. La configuration de la lamelle réunissant la base de la quatrième paire de pattes est représentée sur les figures. Article 2 de la cinquième patte à 4 appendices, dont les 3 épines sont assez allongées. Des mensurations de leurs longueurs respectives sont données sur le tableau, l'ordre pris étant du dedans au dehors, le deuxième chiffre représentant par conséquent la mesure de la soie. Ovisacs grands, allongés. dépassant l'extrémité de la furca ;

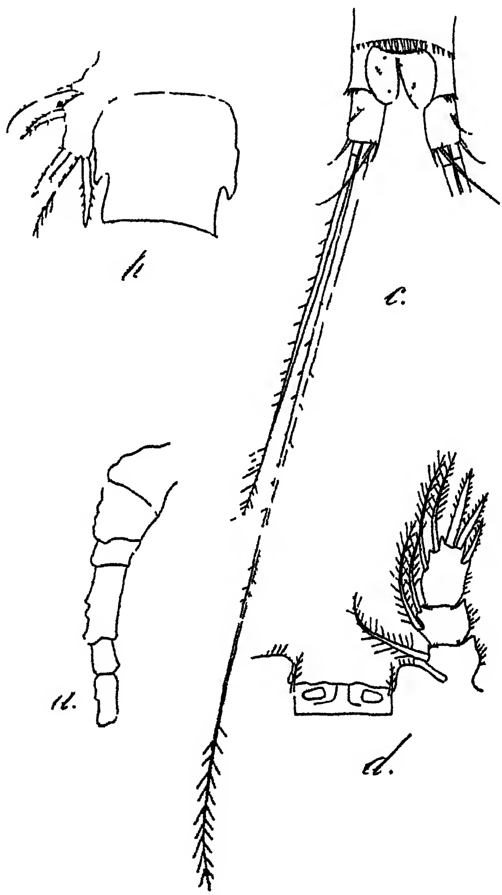

Fig. 3. *Halicyclops thermophilus spinifer* Kiefer. Spécimens de Parak.
a. ♀ Première antenne ; *b.* ♀ P 5 et segment génital ; *c.* ♀ Furca, aspect dorsal ; *d.* ♀ Enp. 4 et lamelle basale.

chez la plupart des individus ils étaient accolés contre l'abdomen. Le plus petit nombre d'oeufs comptés dans un ovisac a été de 8, et le plus grand de 23 ; en moyenne chaque ovisac contenait 15 oeufs. Mâle, longueur de 494 à 513 μ ; largeur de 152 à 167 μ (3 spécimens seulement examinés). Branches de la furca parallèles de 1·25 à 1·47 fois aussi longues que larges. Article 2 de P5 portant 3 épines et 2 soies. P6 composée de 3 appendices ; une longue épine interne, ne dépassant

cependant pas le rebord postérieur du deuxième segment abdominal, et 2 soies, dont la plus interne (l'appendice médian) est très mince et plus courte que la soie externe.

Habitats.—(1) Des marais à eau saumâtre à Bandra et à Kourla (faubourgs de Bombay) avec *C.* (*M.*) *dengizicus* Lepechkine, au mois d'octobre.

(2) Un étang salin près du bord de la mer, à 2 kilomètres au sud de Parak, village de pêcheurs, environ mi-chemin entre Bouchir et Linguéh, avec *C.* (*M.*) *minutus* Claus et *C.* (*M.*) *grandispinifer* Lindberg, au mois de février.

Les animaux étudiés proviennent, dans le cas de ceux de l'Inde, de plusieurs parties différentes des marais à Bandra : ceux de l'Iran ont été récoltés à un même endroit. Toutes les femelles étudiées de Bandra portaient des ovisacs. Seulement la dernière (sur le tableau) des femelles rapportées de Parak était ovigère. Aucun mâle n'y fut trouvé.

Remarques.—C'est en 1925 que Kiefer a fait connaître le premier *Halicyclops* à segment génital pourvu d'épines latérales, le *Halicyclops thermophilus* de Java, et 10 ans plus tard a été décrite la variété *spinifer* d'après des spécimens récoltés à Port Canning, près de Calcutta. De voir en ces animaux une sous-espèce du premier semble en effet tout à fait juste, mais, chose étrange, d'après Kiefer ce n'est pas la similitude de configuration du segment génital qui constitue la raison d'être de cette parenté, mais la dentelure du troisième segment abdominal, car Kiefer a en même temps introduit encore une sous-espèce, le *Halicyclops thermophilus septentrionalis*, dont le segment génital est dépourvu d'épines et présente les protubérances latérales usuelles des autres membres du genre *Halicyclops*. Même s'il est certain que la dentelure particulière en question existe chez tous les individus référables à la variété *H. thermophilus spinifer* il semble bien singulier de voir en cette ornementation une qualité phylogénétique plus importante qu'une modification structurale profonde du segment génital même. Il est évident que la forme qui vient d'être décrite est identique au *Halicyclops thermophilus spinifer* de Calcutta. Les divergences que présentent les animaux du golfe Iranien me semblent trop peu marquées pour nécessiter leur distinction comme une variété différente.

Queleques remarques s'imposent encore au sujet de la nomenclature. Kiefer a en 1936, après avoir démembré en plusieurs espèces le *Halicyclops aequoreus*, considéré jusqu' alors comme une forme cosmopolite, trouvé utile d'abandonner le nom de Fischer en faveur de celui de Boeck (*H. christianiensis*). Ses raisons sont, d'une part la description défectueuse de Fischer, d' autre part la supposition que le *Halicyclops* décrit par Lilljeborg, Boeck et Sars, c'est-à-dire la forme commune dans l'Europe du Nord, n'existe pas à Madère, d'où provenaient les animaux de Fischer. Cependant ce travail a eu le mérite de montrer l'incertitude qui subsiste sur l'identité réelle des animaux exotiques simplement mentionnés comme " *Halicyclops aequoreus* " ou " *magniceps* ", et, en ce qui concerne l'étude présente cette remarque s'applique au sujet de " *H. magniceps* " rapporté par Seymour Sewell du lac Tchilka et de " *H. aequoreus* " de Rylov, trouvé à Bender Pahlévi sur les bords de la mer Caspienne.

Halicyclops thermophilus spinifer Kiefer.

Localité.	Longueur	Furca Long. : larg.	Soies apicales.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. int.: ép. ext.	Enp. 4. Art. 3. Ep. int. : long. art.	P 5. Art 2. Appendices (du dedans au dehors).	P 6 Ep: soie mé l.: soie ext.
Bandra	684	33 : 25=1·32 : 1	22 : 320 : 459 : 17	37 : 27=1·37 : 1	43 : 33=1·30 : 1	43 : 37=1·16 : 1	44 : 43 : 40 : 37	
	617	33 : 23=1·43 : 1	25 : 217 : 392 : 13	37 : 23=1·60 : 1	47 : 30=1·57 : 1	47 : 37=1·27 : 1	....	
	712	30 : 21=1·43 : 1	33 : 203 : 367 : 15	30 : 22=1·36 : 1	40 : 28=1·43 : 1	40 : 30=1·33 : 1	....	
	722	31 : 22=1·41 : 1	38 : 230 : 431 : 13	37 : 25=1·48 : 1	50 : 35=1·43 : 1	50 : 37=1·35 : 1	40 : 43 : 37 : 37	
	589	23 : 20=1·15 : 1	27 : 192 : 384 : 13	33 : 22=1·50 : 1	42 : 32=1·31 : 1	42 : 33=1·27 : 1	47 : 37 : 40 : 37	
	784	27 : 21=1·29 : 1	35 : × : 417 : 16	....	....	....	....	
	712	30 : 23=1·30 : 1	27 : 242 : 442 : 20	37 : 23=1·60 : 1	50 : 33=1·52 : 1	50 : 37=1·35 : 1	....	
	♂494	25 : 17=1·47 : 1	20 : 167 : 325 : 11	27 : 13=2·08 : 1	37 : 23=1·60 : 1	37 : 27=1·37 : 1	...	33 : × : 30
	♂503	20 : 16=1·25 : 1	25 : 170 : 310 : ×	25 : 16=1·58 : 1	37 : 25=1·48 : 1	37 : 25=1·48 : 1	...	33 : 25 : 33
	♂513	....	....	....	....	....	...	27 : 22 : 25
Parak	636	30 : 22=1·36 : 1	33 : 217 : 404 : 16	....	....	....	...	
	622	30 : 22=1·36 : 1	33 : 214 : 392 : 16	33 : 23=1·43 : 1	42 : 30=1·40 : 1	42 : 33=1·27 : 1	....	
	694	32 : 22=1·45 : 1	37 : 220 : × : 15	37 : 23=1·60 : 1	45 : 33=1·36 : 1	45 : 37=1·22 : 1	42 : × : 42 : 33	
	646	32 : 22=1·45 : 1	33 : 220 : 395 : 16	....	....	....	...	
	627	25 : 20=1·25 : 1	28 : 212 : 372 : 16	40 : 23=1·74 : 1	43 : 33=1·30 : 1	43 : 40=1·07 : 1	42 : × : 33 : 33	
	703	28 : 20=1·40 : 1	30 : 210 : 386 : 13	....	....	....	45 : 37 : 40 : 38	
	703	33 : 22=1·50 : 1	35 : 207 : 437 : 13	38 : 25=1·52 : 1	43 : 33=1·30 : 1	43 : 38=1·13 : 1	....	

RÉSUMÉ.

Une description a été donnée d'une espèce nouvelle du genre *Halicyclops* et une rédescription d'une forme du même genre déjà connue de la côte orientale de l'Inde et retrouvée sur la côte occidentale, ainsi que sur le littoral du golfe Iranien.

Quelcues remarques ont été faites au sujet de la nomenclature récente de Kiefer.

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SILUROID FISHES OF INDIA, BURMA AND CEYLON.

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(Plates I and II.)

IX. FISHES OF THE GENERA *Gagata* BLEEKER AND *Nangra* DAY.

Recently while working out collections of freshwater fishes from Assam and Travancore, considerable difficulty was experienced in separating Indian species hitherto referred to the genera *Gagata* Bleeker, *Batasio* Blyth and *Nangra* Day. This led us to examine the entire material of these genera in the extensive collections of the Indian Museum with very interesting results. In this article we propose to deal with the fishes of the genus *Gagata*, of which *Nangra* is regarded as a synonym, while the genus *Batasio* is treated in detail in the next article of this series.

Gagata Bleeker.

1858. *Gagata*, Bleeker, *Ichthyol, Archipel, Ind. Prodromus*, I, p. 204 (orthotype *G. typus* Blkr. = *Pimelodus gagata* Ham.).
1860. *Gagata*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 152.
1863. *Gagata*, Bleeker, *Ned. Tijdschr. Dierk.* I, p. 90.
1861. *Callomystax*, Gunther, *Cat. Fish. Brit. Mus.* V, p. 218.
1877. *Gagata*, Day, *Fish, India*, p. 492.
1877. *Nangra*, Day, *ibid.*, p. 493.
1911. *Gagata*, Regan, *Ann. Mag. Nat. Hist.* (8) VIII, p. 564.
1911. *Nangra*, Regan, *ibid.* (8) VIII, p. 564.
1913. *Gagata*, Weber & de Beaufort, *Fish. Indo-Austral. Archipel.* II, p. 268.

In 1858, Bleeker provisionally proposed the generic name *Gagata* and included a number of heterogenous forms in it. It was not until 1863, however, that its definition was given and *Pimelodus gagata* Hamilton, rechristened as *Gagata typus* Bleeker, definitely assigned to it. As Bleeker had not seen any specimen of Hamilton's species, his characterisation of the genus was imperfect and the systematic position he assigned to it was faulty. However, Blyth recognised *Gagata* as a valid genus, but remarked: " This, as it now stands, is a heterogeneous assemblage of species, and I know of none that can properly range with the type of it, which is *Pimelodus gagata*, B. H.: a species with the maxillary cirri bony towards the base, as in *Bagarius* to a much greater extent. The *Menoda* dubiously referred to this type by Dr. Bleeker is identical with *Bagrus corsula*, Val., which therefore must stand as *B. menoda* (B. H.); the *Mangois* appertaining to my genus *Amblyceps*; and another type may be here indicated as—*Hara*, nobis, n.g." Günther redescribed the species *gagata* from 5 examples, which he regarded as " Types of the species. Presented by G. R. Waterhouse, Esqr.," and erected for it a new genus *Callomystax*. He was aware of Bleeker's *Gagata* but did not consider it a valid genus and remarked:

" Dr. V. Bleeker does not appear to have been acquainted with this fish, so that not only the characters of the genus which he proposed for it are incorrect, but it is also improperly referred to the ' phalanx ' of *Arii*, and to the ' Stirps ' of *Bagrini*."

Later workers, however, regarded *Gagata* Bleeker as a valid genus and considered Günther's *Callomystax* as its synonym Gunther had assigned only one species to this genus, but Day included 4 species in it—*G. cenia* (Ham) with *G gagata* (Ham) as a synonym, *G. itchkeea* (Sykes), *G. batasio* (Ham.) and *G tengana* (Ham.) According to Day, the range of the genus extends from the " Rivers of Sind, India (except Madras) and Burma." One more species—*G schmidti*—has since been described by Volz[1] from Sumatra.

Day established another genus *Nangra* to accommodate *Pimelodus nangra* Hamilton, *P. viridescens* Hamilton and a new species from the Sone River (*Nangra punctata*) and remarked :—

> " This genus differs from *Gagata* in its barbels not being placed in a transverse line behind the chin and in its gill membranes not being confluent with a broad isthmus but rather deeply notched It is allied in some respects to *Macrones*, but has no teeth on the palate, whilst its air-vessel is enclosed in bone. "

Our studies have shown that the characters distinguishing the two genera intergrade into each other and can at best be used for separating species in the same genus.

In order to discuss the systematic position of the above-mentioned species, it is necessary to know, in the first instance, the precise limits of the genus *Gagata* Hamilton. Though quite a number of Hamilton's species are inadequately characterised, there is no difficulty in recognising *P. gagata*, as its detailed description and figure leave no doubt about its identity. Reference may here be made to a few of its most salient features as given by Hamilton.

i. There are eight barbles; the two nasal and the four mandibulary barbels are shorter than the head, while the maxillary barbels are rather longer, and have a membrane extending half way along their hinder edge.
ii. The anal fin is provided with 17 rays.
iii. The fins are edged with black.
iv. The bones of the head are roughened with variously intersecting ridges.
v. The jaws are crowded with minute teeth, while the tongue and the palate are smooth.
vi. Both apertures of each nostril are circular and are separated only by the nasal barbel.

Bleeker (1863, p. 90) based his genus *Gagata* on the following characters :—

> " Cirri 8, nasales 2, supramaxillares 2, inframaxillares 4. Palatum edentulum. Dentes maxillis pluriseriati parvi. Scutum capitis granosum, fonticulis lateralibus Cirri supramaxillares basi membrana muniti. Spina dorsi edentula. B. 5."

Günther gave a good definition of the genus under *Callomystax* and included the following additional important diagnostic characters in it :—

i. The two pairs of mandibulary barbels are inserted in a transverse series immediately behind the margin of the lower lip. The maxillary barbels are osseous to some extent.
ii. The eyes are without free orbital margins.

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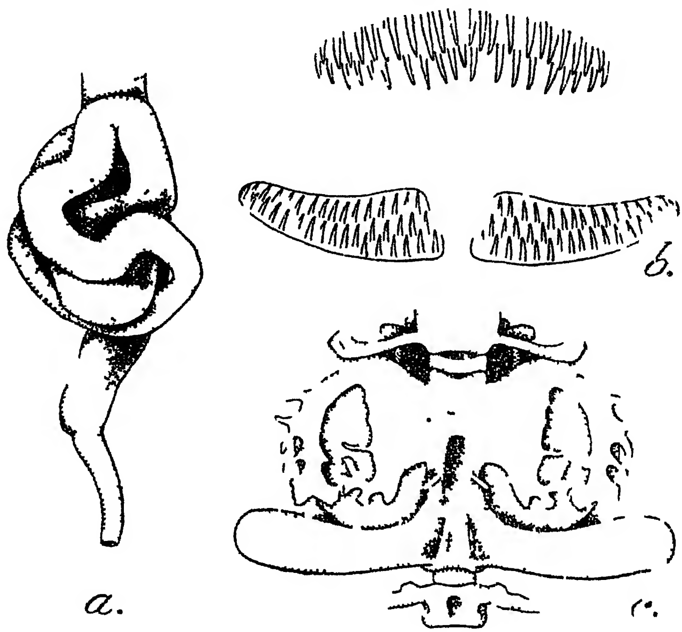
[1] Volz, W., *Revue Suisse de Zool.* XII, p. 470 (1904).

iii. The gill-openings are of moderate width, the gill-membranes being confluent with the skin of the isthmus.

Day added to the generic definition the character of the air-bladder which he found to consist of "two rounded portions, each of which is enclosed in an osseous cup." Regan in his synopsis of the genera of the Sisoridae defined the main skeletal features of *Gagata* and *Nangra*.



Text-fig. 1.—Alimentary canal, dentition and air-bladder of *Gagata gagata* (Hamilton).
***a.* Alimentary canal. ×2½; *b.* Dentition. ×8; *c* Air-bladder. ×3½.**

In view of what is stated above, the genus *Gagata* may be defined as follows:—

Gagata comprises a group of Sisorid fishes in which the body is compressed and the snub-nosed head, though globular, is somewhat elevated, only rarely depressed. The upper surface of the head is provided with sharp, longitudinal ridges; it is covered with thin, smooth skin, but some of the bones on the dorsal surface are variously roughened. The median fontanel is very conspicuous. The mouth is small, transverse and ventral. The lips are thick, continuous and somewhat fimbriated; the post-labial grooves are restricted round the corners of the mouth. The jaws are provided with small, villiform teeth; the palate is edentulous. There are eight barbels; the nasal barbels are small and thin and are prolongations of the broad flaps separating the two nostrils on each side; these flaps, when present, cover a part of the posterior nostrils on each side; the maxillary barbels are osseous proximally, and are provided with membraneous flaps along the inner surface; the two pairs of mandibular barbels are shorter and may or may not be situated in a more or less transverse series behind the posterior lip.

The skin in the thoracic region is smooth. The nostrils are close together. The eyes are subcutaneous. The gill-openings are fairly wide; the gill-membranes may be confluent with the skin of the isthmus, or deeply notched. The rayed dorsal fin is provided with a strong spine. The adipose dorsal is short but prominent. The pectorals are provided with strong spines which are denticulated internally. The pelvics are horizontal and 6-rayed; they are situated behind the dorsal. The anal fin is short. The caudal fin is deeply forked. The air-bladder is divided into two rounded portions which are partially enclosed in bone and come in direct contact with the skin above the pectorals. There are 5 to 7 branchiostegal rays.

Regan distinguished *Gagata* from the other genera of the Sisoridae by the following combination of characters :—

> "Praecaudal vertebrae normal, with the ribs attached to the simple parapophysis and the neural arches without the lateral processes; end of transverse process of fifth vertebra appearing as a rugose plate behind the lateral cutaneous area.
>
> "Head somewhat compressed and elevated; tail and caudal vertebrae normal.
> "Mesopterygoid smaller than metapterygoid, pelvis behind the dorsal.
> "Gill-membranes attached to isthmus."

Further, he distinguished *Nangra* from *Gagata* by the fact that in the former the gill-membranes are free from the isthmus.

Having defined the generic limits of *Gagata* and *Nangra* we may now consider the systematic position of the various species assigned to these genera. Hamilton's *Pimelodus cenia* is undoubtedly congeneric with his *P. gagata.* In the former the author seems to have overlooked the minute nasal barbels. Günther appears to have overlooked this species entirely, for there is no mention of it in his *Catalogue.* Though in 1869, Day[1] recognised it as a distinct species, in his *Fishes of India* and the *Fauna* he considered it as a young form of *Gagata gagata.* We have examined a large series of specimens of both the species in the collection of the Indian Museum and are definitely of the opinion that they are quite distinct and represent two valid species of the genus *Gagata.*

Day (*loc. cit.*, 1877, p. 493) included Hamilton's *Pimelodus batasio*[2] in the genus *Gagata*, and as he had no specimen for study he seems to have been greatly influenced by Hamilton's statement to the effect that "There is no *slit* under the throat........" Cuvier and Valenciennes[3] included this species under *Bagrus*, Blyth[4] under *Batasio* and Günther[5] under *Macrones.* We have examined several specimens of the species from the type-locality and find that Hamilton's statement with regard to a slit under the throat is not correct. In Hamilton's original drawing[6] of the species the two nostrils of each side are shown as situated wide apart, which precludes its being a member of the Sisoridae. This species has been rightly assigned by Shaw and Sheb-

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[1] Day, F., *Proc. Zool. Soc. London*, p. 309 (1869).
[2] Hamilton, F., *Fish. Ganges*, p. 179 (Edinburgh: 1822).
[3] Cuvier, G. and Valenciennes, A., *Hist. Nat. Poisson* XIV, p. 425 (1839).
[4] Blyth, E., *Journ., As. Soc. Bengal* XXIX, p. 150 (1860).
[5] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 83 (1864).
[6] Day, F., *Fish. India*, pl. xcix, fig. 5 (1877); Hora, S. L., *Mem. Ind. Mus.* IX, pl. xxii, fig. 3 (1929).

beare[1] to the genus *Batasio* Blyth, which is dealt with in the next article of this series.

As regards the true systematic position of *Pimelodus tengana* Hamilton there is some difficulty. It has been included under the genus *Bagrus* by Cuvier and Valenciennes, *Batasio* by Blyth, *Macrones* by Günther and *Gagata* by Day. This species was collected by Hamilton in the Brahmaputra and in his original notes the description is dated "Gualpara, 29th July, 1808." To elucidate its systematic position attention may be directed to the following salient features as noted by Hamilton :—

1. There are eight barbels shorter than the head.
2. The anal fin possesses fourteen rays.
3. It is a small fish of about 3 inches in length.
4. The back is marked with many black dots, which are collected into a spot above each pectoral fin, and also on the crown of the head. The fins of the back and tail are also dotted, so that the edge of the last is black, and several spots are formed on the first.
5. Both openings of each nostril are circular, with a tendril between them.
6. Under the lower jaw there is no slit.

Though it is stated by Hamilton that the two openings of each nostril have a barbel between them, his figure shows that these openings are situated widely apart and that the posterior one is provided with a barbel at the anterior end. It would thus appear that the species cannot be referred to the Sisoridae, but belongs to the Bagridae. It seems to belong to the genus *Batasio* and is conspecific with Blyth's *B. affinis*. We shall elucidate further the systematic position of this species in our account of the fishes of the genus *Batasio*.

Hamilton's *P. nangra*, the type of Day's genus *Nangra*, differs from *Gagata gagata* and *G. cenia* in having longer barbels and deeply notched gill-membranes, though Hamilton in the description of this species also states "There is no *slit* under the throat." The bases of the mandibular barbels are not situated in a straight line. As indicated above, we do not regard these differences of generic value, especially as *Gagata itchkeea* (Sykes) is a form intermediate in characters between *Gagata* and *Nangra*.

In *Pimelodus viridescens*, Hamilton mentioned only six barbels; evidently he overlooked the minute nasal barbels. The most significant feature of this species is its greatly depressed head and anterior part of body. It is stated to possess a slit under the throat. From a careful study of Day's descriptions of *Nangra punctata* and *Nangra viridescens* and also from an examination of his drawings of the two species it seems probable that the two are identical, the latter being the juvenile form of the former. Two fresh specimens in our collection also confirm this view. In the nature of its gill-openings, *G. viridescens* agrees with *G. nangra*. Day recorded this species from Poona and one of us[2] also recorded it from the Deccan. Re-examination of the

[1] Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, p. 97, fig. 98 (1938).

[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 19 (1937).

material has shown that the Deccan specimens are referrable to *G. itchkeea* in which the isthmus is very narrow and the mandibular barbels are not situated in an absolute straight line.

The only extra-Indian species of *Gagata* is *G. schmidti* Volz from Sumatra. Its salient features are the depressed head, 1½ times broader than high; the small eyes. longitudinal diameter being contained 13 times in length of head; the absence of fontanels; the dorsal spine being dentated along the front and hind borders; the very narrow isthmus, and its almost uniform gray brown colour.

The Indian species of the genus *Gagata* may be distinguished by the following key:—

Key to the Indian species of the genus Gagata *Bleeker.*

I. Nasal barbels small or rudimentary, being almost as long as or considerably shorter than longitudinal diameter of eye.

- A. Dorsal fin considerably longer than head; both dorsals, anal, pectoral and pelvic fins black distally.
  [Gill-membranes united with a fairly broad isthmus; maxillary barbels slightly and mandibular barbels considerably shorter than head; bases of mandibular barbels close together and in a transverse row; median groove on head extending to end of occipital process] .. .. *G. gagata.*
- B. Dorsal fin considerably shorter than head; distal portions of fins not coloured black.
  1. Maxillary barbels longer than head. [Gill-membranes united with a very narrow isthmus; mandibular barbels somewhat shorter than head; bases of inner mandibular barbels somewhat in advance of those of the outer; median groove on head extending as far as posterior border of orbit and followed by a small, median, oval fontanel] .. *G. itchkeea.*
  2. Maxillary barbels considerably shorter than head.
     - *a*. Bases of mandibular barbels close together and in a transverse row. [Gill-membranes united with a narrow isthmus; width of head considerably less than its length in front of pectorals; median groove on head extending to base of occipital process] .. *G. cenia.*
     - *b*. Bases of mandibular barbels set widely apart, and at different levels. [Gill-membranes united with each other and the isthmus; head almost as broad as its length in front of pectorals; median groove on head extending to base of occipital process] .. *G. viridescens.*

II. Nasal barbels almost as long or longer than head. [Bases of mandibular barbels set widely apart, and at different levels; gill-membranes united with each other across the isthmus; maxillary and outer mandibular barbels much longer than head; median groove on head extending to base of occipital process] .. .. *G. nangra.*

Gagata gagata (Hamilton).

Plate I, figs. 1, 2.

1822. *Pimelodus gagata*, Hamilton, *Fish. Ganges*, pp. 197, 379, pl. xxxix, fig. 65.
1854. *Pimelodus gagata*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
1858. *Gagata gagata*, Bleeker, *Ichthyol. Archipel. Indici, Prodromus*, I, *Siluri*, p. 206.
1860. *Gagata gagata*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 151.
1862. *Gagata typus*, Bleeker, *Atl. Ichthyol.* II, p. 7.
1864. *Callomystax gagata*, Gunther, *Cat. Fish. Brit. Mus.* V, p. 218.
1869. *Gagata typus*, Day, *Proc. Zool. Soc. London*, p. 309.
1877. *Gagata cenia*, Day (in part), *Fish. India*, p. 492, pl. cxv, fig. 4.
1877. *Callomystax gagata*, Beavan, *Freshw. Fish. India*, p. 149.
1889. *Gagata cenia*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 208, fig. 75.

D. 1/6; A. 3-4/10-12; P. 1/9; V. 1/5; C. 19.

Gagata gagata is a medium-sized, stoutly-built species in which the dorsal profile rises moderately to the commencement of the dorsal fin beyond which it slopes down gradually to the base of the caudal fin. The ventral profile is almost horizontal as far as the commencement of the pelvic fins and thereafter it rises gradually to the base of the caudal fin. The fish is compressed from side to side, more so in the posterior half; the dorsal surface forms a narrow ridge. The ventral surface in front of the pelvic fin is somewhat flattened.

The head is broadly pointed in front; its length is contained from 3·61 to 3·93 times in the standard length. The height of the head at the occiput is contained from 1·05 to 1·45 times and its width from 1·25 to 1·57 times in its length. The snout is prominent and globular; it is produced in front of the mouth for a short distance. The eyes are dorso-lateral in position and are situated nearer to the posterior margin of the operculum than to the tip of the snout. The diameter of the eye is contained from 2·65 to 3·76 times in the length of the head, from 0·89 to 1·58 times in the length of the snout and from 0·65 to 1·20 times in the inter-orbital width. The two nostrils of each side are fairly prominent, close together and situated much nearer to the tip of the snout than to the eye. The dorsal surface of the head is covered with smooth skin but is marked with bony ridges. The median groove on the head commences from in front of the nostrils and is continued with slight variations to the end of the occipital process which misses the basal bone of the dorsal fin by a short distance. The occipital process is long and narrow, almost 4 to 5 times as long as broad at its base. The mouth is small and horizontal; it is bordered by thick and slightly fimbriated lips which are continuous at the angles of the mouth. There are patches of small, villiform teeth in the jaws. There are four pairs of barbels; the nasal barbels are small and thin and are rarely as long as the longitudinal diameter of eye. The maxillary barbels possess

stiff bony bases and membranous flaps along the inner side of the proximal one-third of their lengths. These barbels rarely exceed the length of the head. The two pairs of mandibular barbels have somewhat swollen bases which are arranged in a transverse row behind the lower lip; these barbels are shorter than half the length of the maxillary barbels. The gill-opening is restricted on the ventral surface; the distance between the two openings is contained from 0·55 to 0·92 times in the diameter of the eye.

The depth of the body is contained from 3·34 to 4·37 times in the standard length. The caudal peduncle is well formed; its least height is contained from 1·28 to 2·00 times in its length. Two oval patches of skin above the pectorals indicate the areas where the air-bladder comes directly in contact with the skin. The cubito-humeral processes are fairly well marked. The anal opening is situated nearer to the commencement of the caudal fin than to that of the pectorals. The urino-genital openings[1] are separate; in the female they are situated immediately behind the anus and form a slit-like aperture bordered by fleshy lips which project in the form of a short papilla-like structure distally. In the male the urinary opening is situated on a papilla behind the anus.

The dorsal fin is pointed and situated almost wholly in advance of the pelvic fins; it is longer than the head; its spine is long, pointed and almost as long as, slightly shorter or longer than the head. It is finely serrated along the distal one-third of the anterior border. The adipose fin is short, but well marked; its base is somewhat longer than that of the rayed dorsal. The pectoral fins are also pointed and are placed only slightly above the ventral surface; they do not extend to the base of the pelvic fins. The pectoral spine is strong and denticulated internally; its outer border is provided with a few teeth at the distal end. The pelvic fins extend considerably beyond the anal opening and their outer rays are pointed. The anal fin is of moderate length and the caudal fin is deeply forked with both the lobes pointed, the upper lobe is somewhat better developed than the lower.

The general colour of the body is opaque yellow verging to dull gray. The greater part of the pectorals, the distal halves of the dorsal, pelvic, and anal fins are conspicuously coloured black. The caudal fin is whitish. The colouration of the species is one of its most characteristic features.

Distribution.—Unfortunately a number of specimens of *Gagata gagata* in the collection of the Indian Museum do not bear locality labels, but it seems probable that the species is found in the Ganges, Brahmaputra and Irrawadi River systems. It is represented in the collection from Allahabad, Calcutta, Khulna and Prome. It is said to attain a foot in length.

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[1] Urino-genital structures similar to those described here are erroneously termed by Mookerjee, Mazumdar and Das Gupta as "vagina" and "penis" (*Ind. Journ. Vet. Sci. Animal Husb.* X, p. 295, 1940). The authors seem to have ignored the fact that in teleosts the "urinary opening may be separate or confluent with that of the genital ducts and is frequently placed on a more or less prominent papilla (*papilla urogenitalis*). If separate, the urinary opening is behind the genital; and if a papilla is developed, its extremity is perforated by the urethra, the genital opening being situated near the base" (Günther, *Introduction to the Study of Fishes*, p. 156, 1880).

Measurements in millimetres of the specimens of *Gagata gogata* (Ham.)

—	Allahabad.	Hooghli R., Bengal.				Pusar R., Khulna, Bengal.	Prome, Burma.	Locality unknown.						
Standard length	102·0	77·0	79·0	94·0	97·5	83·5	118·0	81·5	90·0	90·5	92·0	120·0	139·0	143·0
Length of head	26·0	20·0	20·5	24·5	26·0	22·0	30·5	21·5	23·5	23·0	23·5	32·0	38·5	38·0
Height of head at occiput ..	20·5	16·0	19·5	21·0	20·5	17·0	21·0	16·5	19·0	19·5	17·0	26·0	27·5	28·5
Width of head	18·5	15·5	13·0	19·5	18·5	17·5	19·5	17·0	16·5	17·5	16·0	23·0	25·0	25·0
Length of snout	10·0	8·0	8·5	9·5	10·5	8·5	12·5	8·5	10·0	10·0	9·5	13·5	13·0	16·0
Diameter of eye	8·5	6·5	5·0	8·0	8·0	7·0	10·5	7·5	7·0	7·5	6·5	8·5	14·5	12·0
Interorbital width ..	8·0	7·0	6·0	7·5	9·0	8·0	8·0	6·5	8·0	7·0	7·0	9·5	9·5	9·5
Depth of body	28·5	23·0	21·0	26·0	26·5	22·5	27·0	21·5	26·5	25·5	24·5	33·0	36·0	33·5
Length of caudal peduncle ..	17·0	9·0	11·0	14·0	13·0	13·0	18·5	10·5	12·0	13·0	13·5	16·0	21·5	23·0
Least height of caudal peduncle.	8·5	7·0	7·5	7·5	8·5	7·5	11·0	7·0	8·0	8·0	8·5	11·0	13·0	11.5
Longest ray of dorsal ..	33·5	25·0	23·5	31·5	37·5	27·5	29·0	28·0	30·0	35·0	34·5	40·5	42·0	38·5
Length of dorsal spine ..	27·5	20·0	19·0	27·0	29·0	23·0	25·0	23·5	24·0	29·0	25·0	33·5	35·5	D.
Length of pectoral ..	28·5	22·0	21·5	28·0	29·5	22·0	30·5	22·0	14·0	27·0	28·0	32·5	43·5	42·0
Length of pectoral spine ..	25·5	19·0	19·0	24·5	26·5	21·5	28·0	21·0	22·0	25·0	24·5	30·5	39·0	37·0
Length of ventral ..	18·0	13·0	13·5	18·0	18·5	15·5	18·0	14·0	14·5	17·5	15·5	21·0	26·5	25·5
Longest ray of anal ..	21·0	D.	12·0	18·5	19·0	D.	18·5	15·0	17·0	21·0	17·0	D.	30·0	D.
Length of base of anal ..	16·0	11·0	11·0	13·5	13·5	11·5	17·0	12·0	14·0	15·0	14·5	17·5	19·5	20·0
Length of base of adipose dorsal.	16·5	11·5	10·5	14·5	13·0	8·5	15·0	12·5	10·5	10·0	14·0	14·0	16·5	16·0

Gagata itchkeea (Sykes).

Plate I, figs. 3, 4.

1840 *Phractocephalus itchkeea*, Sykes, *Trans. Zool. Soc. London* II, p. 373, pl lxvii, fig. 1.

1849. *Pimelodus itchkeea*, Jerdon, *Madras Journ. Litt. Sci.* XV, p. 341.

1854 *Bagrus itchkeea*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.

1864. *Macrones itchkeea, Cat. Fish. Brit. Mus.* V, p. 84.

1876 *Hemipimelodus itchkeea*, Day, *Journ. Linn. Soc. London, Zoology* XII, p. 571.

1877 *Gagata itchkeea*, Day, *Fish. India*, p. 492, pl. cxv, fig. 6.

1889. *Gagata itchkeea*, Day, *Faun. Brit. Ind.*, *Fish* I, p. 209.

1937. *Nangra viridescens*, Hora (*nec* Hamilton), *Rec. Ind. Mus.* XXXIX, p. 19.

1937. *Nangra viridescens*, Hora & Misra (*nec* Hamilton), *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 511; *ibid.* XL, p. 23, 1938.

D. 2/6; A. 2-3/9-10; P. 1/8; V. 1/5; C. 18-19.

Gagata itchkeea is a small, almost cylinderical fish in which both the dorsal and the ventral profiles are slightly arched. The body is only slightly compressed anteriorly, but in the region behind the pelvic fins the compression is more marked. The ventral surface in front of the pelvic fins is only slightly flattened and, in consequence, the pectoral fins are placed at a considerably higher level than the ventral surface.

The head is short, globular and rounded anteriorly; its length is contained from 3·57 to 4·05 times in the standard length. The height of the head at the occiput is contained from 1·25 to 1·50 times and its width from 1·16 to 1·50 times in its length. The snout is so much rounded that one gets the impression of a pug-headed fish and the nostrils are almost directed anteriorly; it projects beyond the mouth for a short distance. The eyes are large and dorso-lateral in position; they are not visible from the ventral surface. The diameter of the eye is contained from 2·20 to 2·75 times in the length of the head, from 0·60 to 1·00 times in the length of the snout and from 0·63 to 0·87 times in the interorbital distance. The nostrils are large and well formed and are situated almost midway between the tip of the snout and the eyes. The median groove on the head extends from between the nostrils to the base of the occipital process, but anteriorly there are lodged in it one large and one small fontanels. After the second fontanel the groove is very shallow and hardly perceptible posteriorly. The edges of the groove are slightly raised to form longitudinal ridges. The occipital process is long and narrow, its length is about 3 times its width at the base; it is separated from the basal bone of the dorsal fin by a short distance. The mouth is small, inferior and horizontal; it is bordered by fleshy lips which are continuous and free at the angles of the mouth. The teeth are small, villiform, and hardly perceptible. There are four pairs of barbels: the nasal barbels are small and considerably shorter than the diameter of the eye; the maxillary barbels are longer than the head and their basal parts stiff; the membrane in

their axils is little developed; the two pairs of mandibular barbels are almost equal and are as long as the head behind the anterior border of the orbit. The bases of the mandibular barbels are not situated exactly in a transverse line behind the lower lip, but those of the inner pair are slightly in advance of those of the outer. The gill-membranes are attached to the isthmus but the gill-openings are separated by a distance which is generally less than one-fifth of the diameter of the eye.

The depth of the body is contained from 4·00 to 5·41 times in the standard length. The least height of the caudal peduncle is contained from 1·14 to 1·85 times in its length. The portion of the body where the air-bladder comes in close contact with the skin is not well marked externally, but the cubito-humeral processes are fairly distinct. The anus is followed by a small urino-genital papilla.

The dorsal fin is situated in advance of the pelvic fins; it is generally shorter than the head. The dorsal spine is a strong prickle which is smooth along both the borders. The adipose dorsal is small, but well developed. The pectoral fin is pointed and almost reaches the base of the pelvic fins; its spine is strong and crenulated along the outer border but serrated for two-thirds of its length internally. The pelvic fins extend beyond the anal opening, but are separated from the anal fin by a short distance. The anal fin is short like the dorsal. The caudal fin is deeply forked; both the lobes are pointed, the upper being somewhat longer.

Sykes noted that the colour of the fish is "yellowish glossy silver, inclining to greenish on the back, and silvery on the belly; marked with dark bluish brown broad spots along the back, head, and at the base of the rays of the tail". Day remarked that the colour is "yellowish-bronze, becoming silvery on the sides and abdomen: some dark blotches along the back descending to half way down the sides. A black blotch on either lobe of the caudal, and another on the dorsal fin". In the specimens examined by us the colour varies only slightly from the earlier descriptions, and the saddle-shaped black bands on the body though only faintly marked in some are fairly conspicuous in others.

Distribution.—As stated by Day, *G. itchkeea* is found only in the rivers of the Deccan. In the collection of the Indian Museum, this species is represented from Deolali, Poona, Satara (Bombay Presidency) and from the Cauvery in the Coorg State.

Remarks.—*G. itchkeea* is intermediate between *G. gagata* and *G. nangra* in several respects and on account of its wide gill-openings and the disposition of the bases of the mandibular barbels is liable to be referred to the genus *Nangra*. Its relatively longer barbels also show its affinity to *G. nangra*. Sykes considered it a close ally of Hamilton's *Pimelodus tengana*, which we have referred to the genus *Batasio* Blyth. *G. itchkeea* rarely exceeds three inches in length and seems to be very common in the waterways at Poona.

Measurements in millimetres of the specimens of *Gagata itchkeea* (Sykes).

—	Deolali.	Poona.					Satara.		Coorg.	Bombay market.	Meema.
Standard length	38·0	38·5	40·5	42·5	46·0	46·5	47·0	49·0	50·0	41·0	40·0
Length of head	10·0	10·5	10·0	11·0	12·5	11·5	13·0	13·0	14·0	11·0	10·5
Height of head at occiput	7·0	7·0	8·0	7·5	8·5	9·0	9·0	9·5	10·5	7·5	7·5
Width of head	7·0	7·0	8·0	8·0	8·5	9·5	9·0	10·5	12·0	9·0	7·5
Length of snout	3·5	3·5	3·0	4·0	4·0	3·0	4·5	5·0	4·0	4·0	3·5
Diameter of eye	4·5	4·5	4·5	4·0	5·5	5·0	5·0	5·0	6·0	5·0	4·5
Interorbital width	3·0	3·0	3·0	3·5	3·5	3·5	3·5	4·0	4·0	3·5	3·0
Depth of body	8·0	9·5	9·0	10·0	8·5	11·0	11·5	11·0	12·5	9·0	8·0
Length of caudal peduncle	4·0	5·5	6·5	7·0	5·0	7·0	7·0	7·5	8·5	5·0	4·0
Least height of caudal peduncle	3·0	3·5	3·5	4·0	4·0	4·0	4·5	5·0	5·0	4·0	3·5
Longest ray of dorsal	8·5	9·0	9·0	11·0	11·0	10·5	11·8	12·0	13·0	10·5	10·5
Length of dorsal spine	6·0	7·5	8·0	9·0	9·0	8·5	9·8	10·4	9·5	8·0	8·0
Length of pectoral	11·0	11·0	10·5	12·0	12·0	12·5	14·0	13·5	15·5	13·0	13·0
Length of pectoral spine	9·0	8·0	9·5	10·0	10·5	11·5	12·5	12·0	14·0	11·0	11·5
Length of ventral	7·0	6·0	6·5	8·0	7·5	7·0	8·0	8·5	9·5	7·5	6·5
Longest ray of anal	8·0	7·5	8·0	7·0	8·5	9·0	10·0	10·5	11·5	8·0	D.
Length of base of anal	6·5	5·5	6·5	6·8	5·5	6·0	7·0	8·5	8·0	6·5	6·0
Length of base of adipose dorsal	8·0	5·0	5·5	6·5	5·0	6·0	7·0	7·0	7·5	5·5	6·0
Width of isthmus	0·5	0·9	1·0	0·8	1·0	0·95	1·0	1·0	0·3	0·9	1·5

Gagata cenia (Hamilton).

Plate I, figs. 5, 6.

1822. *Pimelodus cenia*, Hamilton, *Fish. Ganges*, pp. 174, 376, pl. xxxi, fig. 57.
1854. *Pimelodus cenia*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
1869. *Hemipimelodus cenia*, Day, *Proc. Zool. Soc. London*, p. 308.
1871. *Hemipimelodus cenia*, Day, *Proc. Zool. Soc. London*, p. 288.
1877. *Gagata cenia*, Day (in part), *Fish. India*, p. 492, pl. cxv, fig. 5.
1889. *Gagata cenia*, Day (in part), *Faun. Brit. Ind.* Fish. I, p. 208.
1890. *Gagata cenia*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genera* (2) IX, p. 121.
1921. *Gagata cenia*, Hora, *Rec. Ind. Mus.* XXII, p. 182.
1938. *Gagata cenia*, Hora, *Rec. Ind. Mus.* XL, p. 180, fig. 6.
1939. *Gagata cenia*, Das, *Rec. Ind. Mus.* XLI, p. 448.

D. 2/6; A. 2-3/10-12; P. 1/7-9; V. 1/5; C. 17-19.

Gagata cenia is a comparatively small and slender fish, in which the dorsal and the ventral profiles are slightly arched. The body, however, becomes considerably narrow in the caudal region. The ventral surface in front of the pelvic fins is flattened and horizontal. The dorsal surface is somewhat rounded and the head and the body, except in the tail region, are moderately compressed.

The head is flattened on the ventral surface and more or less rounded anteriorly; its length is contained from 3·62 to 4·47 times in the standard length. The height of the head at the occiput is contained from 1·29 to 1·87 times, and its width from 1·40 to 2·00 times in its length. The snout is prominent, globular and projects beyond the mouth for a considerable distance. The eyes are large and dorso-lateral in position; they are not visible from the ventral surface. They are situated either in the middle of the head or slightly nearer to the posterior margin of the operculum than to the tip of the snout. The diameter of the eye is contained from 1·87 to 3·41 times in the length of the head, from 0·62 to 1·33 times in the length of the snout and from 0·50 to 0·85 times in the interorbital width. The nostrils are situated almost midway between the eye and the tip of the snout or slightly nearer to the former than to the latter. The head is covered with smooth skin, but its dorsal surface is marked with two longitudinal bony ridges and the supra-orbital bones are also slightly raised above the surface. The median groove on the head commences from in front of the nostrils and after a slight interruption is continued to a point in front of the base of the occipital process. The occipital process is about three times as long as broad at its base and misses the basal bone of the dorsal fin by a short distance. The mouth is small, horizontal and crescentic; it is bordered by fleshy lips which are free and continuous at the angles of the mouth. The median portion of the upper lip is swollen and plicated; it forms a prominent fold in front of the mouth. There are small and villiform teeth in the jaws. There are four pairs of barbels; the nasal barbels are so minute that they are likely to be overlooked; the basal portions of the maxillary barbels are stiff and there is a thick membrane in their axils; they are slightly shorter than the head; the mandibular barbels are considerably shorter and their bases are situated in a transverse series behind the lower lip. In a very large number of

specimens there are two finger-like processes situated in the mid-ventral line between the bases of the inner mandibular barbels. Sometimes these structures are represented by nodules attached to the posterior lips, while in certain specimens they are entirely absent. These structures, like the barbels, are probably tactile in function. The gill-openings are somewhat restricted on the ventral surface by a narrow isthmus; the distance between the gill-openings is contained from 0·15 to 0·63 times in the diameter of the eye.

The depth of the body is contained from 4·0 to 6·0 times in the standard length. The least height of the caudal peduncle is contained from 1·27 to 2·14 times in its length. The portion of the body where the air-bladder comes in contact with the skin is not well marked externally and the cubito-humeral processes are not so prominent. The urino-genital openings are similar to those described above for *Gagata gagata* (*vide supra*, p. 16).

The dorsal fin is obliquely truncate and its base is situated wholly in advance of the pelvic fins; it is usually shorter than the head, but in rare cases it may be just as long as the head. The dorsal spine is a short, strong prickle which is smooth along the posterior border but is finely serrated along the anterior border, especially along the distal portion. The adipose dorsal is short but well marked. Generally the pectoral fin is shorter than the head, but sometimes it is equal to or even slightly longer than the head; they are separated from the pelvic fins by a considerable distance. The pectoral spine is denticulated in the middle along its inner border and serrated along the distal half of the outer border. The pelvic fins reach as far as or extend slightly beyond the anal opening. The anal fin is short and low. The caudal fin is deeply forked and both the lobes are sharply pointed; the upper lobe is somewhat longer than the lower.

Hamilton noted that "The general *colour* is silver, with some dusky on the back, and the bars descending to the lateral lines. The end of the tail is black; and the first fin of the back, and that of the tail, are stained with the same colour. The eyes are silver-coloured." He had also noted that the back was marked with four transverse bars. Day, who regarded this species as comprising of young individuals only, stated that "The *young* are of a yellowish bronze colour, becoming silvery on the abdomen: they have three dark bands over the head and four more over the back, descending as low as the lateral-line. Caudal with a semi-lunar black band, or a black blotch on each lobe: a dark mark across the dorsal fin." The specimens in the collection of the Indian Museum vary slightly as regards colouration but in general agree closely with Day's description.

Distribution.—Hamilton described this species from the northern parts of Bengal, but as Day had confused *Gagata gagata* with *G. cenia*, it is not possible to accept the range of distribution of this species given by him. In the collection of the Indian Museum, it is represented from the Punjab, Delhi, Nepal, Bihar, Orissa, Bengal, and Assam (including Chindwin Drainage System). It rarely exceeds six inches in length and was originally described by Hamilton from specimens about three inches in length.

Measurements in millimetres of specimens of *Gagata cenia* (Ham.).

	Manipur, Assam.					Chutri Gouri in Terai, Nepal.		Calcutta and Nawabgunge, Bengal.			[illegible]hat and Damodar River, Bihar.			Orissa.	Delhi.		Chenab Canal, Punjab.
Standard length ..	56·5	59·5	65·0	72·5	84·5	59·0	77·0	63·5	38·0	42·5	59·0	63·0	42·0	55·0	60·0	78·5	52·0
Length of head	14·0	15·0	15·5	18·0	23·0	16·2	20·5	17·5	8·5	11·0	16·0	17·0	11·5	15·0	18·2	21·5	14·0
Height of head at occiput .	10·0	10·0	12·0	11·5	13·5	10·0	12·5	10·0	5·5	6·0	8·5	9·5	6·5	8·5	11·0	12·0	7·5
Width of head	8·5	9·0	11·0	10·5	13·0	9·0	11·5	9·2	5·5	6·0	8·5	9·0	6·0	7·5	9·2	11·2	8·0
Length of snout	5·5	5·0	5·5	7·0	8·0	5·5	8·0	6·0	3·0	3·5	6·0	7·0	4·5	5·0	7·2	8·0	6·0
Diameter of eye	6·5	8·0	7·0	7·5	7·0	5·5	6·0	5·5	3·5	4·0	5·5	7·0	4·0	6·0	6·5	7·0	5·0
Interorbital width ..	4·0	4·0	4·0	5·5	6·0	4·0	5·0	4·0	2·5	2·0	3·5	4·0	2·8	3·5	3·5	5·0	3·0
Depth of body	11·0	12·0	14·0	14·0	17·0	10·0	13·0	12·0	6·5	8·5	10·5	10·5	10·5	9·5	11·4	13·5	10·0
Length of caudal peduncle ..	8·0	8·5	9·0	8·5	10·0	8·0	11·0	7·5	5·0	6·0	8·0	7·0	7·0	7·5	9·0	10·0	6·5
Least height of caudal peduncle	5·0	5·0	6·0	6·5	7·0	5·0	5·5	5·0	3·5	4·5	4·5	5·5	4·0	3·5	5·5	6·5	3·5
Longest ray of dorsal ..	12·5	14·0	15·0	14·5	22·5	14·0	17·0	13·0	8·5	11·0	13·0	13·5	10·5	11·5	13·5	16·0	11·0
Length of dorsal spine ..	11·0	11·0	12·0	D.	15·5	11·0	15·0	12·0	7·5	9·5	11·5	12·0	9·5	9·5	13·0	14·5	10·0
Length of pectoral ..	15·0	15·0	16·0	D.	20·5	13·0	18·0	13·0	8·5	12·5	12·0	14·5	10·0	11·5	15·5	17·5	11·5
Length of pectoral spine ..	12·0	13·5	14·0	D.	18·0	11·5	17·5	12·5	8·0	10·0	13·0	14·0	9·5	11·0	14·0	17·0	10·5
Length of ventral ..	8·5	10·0	11·0	12·5	14·0	9·0	11·0	9·5	6·0	7·0	12·5	9·5	6·0	7·5	10·5	12·0	7·5
Longest ray of anal ..	10·5	10·5	12·0	14·0	14·5	9·5	10·5	9·5	9·0	8·5	10·0	10·0	7·0	7·0	11·0	12·0	8·0
Length of base of anal ..	9·0	9·0	11·0	11·5	13·0	8·5	11·0	8·5	9·5	9·0	9·0	9·5	6·0	8·5	9·0	9·5	8·5
Length of base of adipose dorsal.	9·0	8·5	8·5	12·0	10·5	8·0	10·0	6·5	4·5	6·0	7·0	8·5	6·5	6·5	8·5	10·5	8·0
Width of isthmus ..	1·0	1·2	D.	1·0	3·0	3·5	3·5	3·0	0·8	1·0	1·0	2·5	1·5	3·0	2·5	5·0	2·0

Gagata viridescens (Hamilton).

Plate I, figs. 7, 8.

1822. *Pimelodus viridescens*, Hamilton, *Fish. Ganges* pp. 173, 376, pl x, fig. 56.
1854 *Pimelodus viridescens*, Bleeker, *Verh Bat. Gen.* XXV, p 58.
1877. *Nangra punctata*, Day, *Fish, India*, p. 494, pl cxv, fig. 8.
1877 *Nangra viridescens*, Day, *Fish. India*, p 494, pl. cxv, fig. 7.
1889. *Nangra punctata*, Day, *Faun Brit. Ind. Fish.* I, p. 212. fig. 76
1889 *Nangra viridescens*, Day, *Faun Brit. Ind. Fish.* I, p. 212.

D. 1/6; A. 2/9; P. 1/8; V. 1/5; C. 21.

In *Gagata virridescens* the head and the body in front of the anal fin is greatly depressed and the ventral surface is flattened. The tail is somewhat compressed and subcylindrical. The dorsal profile is slightly arched, while the ventral profile is straight and horizontal in front of the anal fin.

The head is large and broad, it is covered with minute spine-like structures: its length is contained from 3·00 to 3·18 times in the standard length. The height of the head is contained from 1·63 to 1·78 times and its width from 1·27 to 1·31 times in its length. The snout is broad and rounded in front; it projects beyond the mouth for a considerable distance. The eyes are of moderate size and dorso-lateral in position; they are not visible from the ventral surface. The eyes are relatively larger in young specimens and are situated almost in the middle of the length of the head; their diameter is contained from 3·50 to 4·16 times in the length of the head and from 1·37 to 1·75 times in the length of the snout. The interorbital distance is equal to the diameter of the eye. The nostrils are well-formed, rounded apertures; they are situated much nearer to the tip of the snout than to the eyes. The median groove on the head is pointed both anteriorly and posteriorly, and extends from in front of the nostrils to the base of the occipital process; behind the level of the eyes there is a slight ridge across the groove. The occipital process is long and club-shaped; its width at the base is contained about 4 times in its length; it misses the basal bone of the dorsal fin by a short distance. The mouth is wide, inferior and horizontal; it is provided with fleshy lips which are continuous at the angles of the mouth. The anterior lip is papillated, and both the lips at the angles of the mouth are plicated. The posterior lip is also somewhat roughened along its middle part. The teeth are small and villiform: they are arranged in bands in the jaws. There are four pairs of barbels; the nasals are minute or rudimentary and are liable to be overlooked altogether; the maxillary barbels are considerably shorter than the head, are provided with stiff basal portions which lie in lateral grooves; the mandibular barbels are much shorter and their bases are situated wide apart, those of the inner pair are considerably in advance of those of the outer pair. The gill-openings are wide and extensive; the gill-membranes are confluent with each other and with the isthmus in the mid-ventral line. The width of the isthmus is very narrow.

The depth of the body is contained from 4·45 to 4·54 times in the standard length. The least height of the caudal peduncle is contained

from 1·63 to 1·71 times in its length. The portion of the body where the air-bladder comes directly in contact with the skin is not well marked externally. The cubito-humeral processes are well developed. The external urino-genital organs are similar to those described in *G. gagata* (*vide supra*, p. 16).

The dorsal fin is short and low, and is situated wholly in front of the pelvics; it is considerably shorter than the head and is provided with a small, strong spine, which is smooth along both the borders. The adipose dorsal is short, but well marked; the length of its base is almost equal to that of the rayed dorsal The paired fins are horizontally placed; the pectorals are shorter than the head and provided with a very strong spine which is smooth along the outer border, but is strongly denticulated internally. The pectorals are separated from the ventrals by a considerable distance. The pelvics are small and pointed and extend beyond the anal opening. The caudal fin is deeply forked, with both the lobes pointed and subequal.

Hamilton stated that in his *Pimelodus viridescens* "The sides are silver *coloured*, the belly livid, and the fins of the back and tail spotted." The back is noted to be "reddish-brown, crossed by three green bars; and with opaque spotless sides". Day described the colouration of his *Nangra punctata* as follows: "coppery, glossed with gold on the sides: a black blotch on occiput, and three or four along the back descending half way down the sides. A black band on dorsal, and some black markings on the caudal." In his *N. viridescens*, which seems to represent young specimens, the colour is "glossy greenish-brown on the back, with two very light green bands passing one from the base of either dorsal fin to the middle of the depth of the body. A dark band on the dorsal fin and spots on either lobe of the caudal". In a young specimen, 44·5 mm. in standard length, besides the two short bands mentioned by Day, there are two other, one obliquely passing through the posterior part of the head and another on the back in front of the base of the caudal fin. The colouration of the larger specimen corresponds fairly closely with that of Day's *N. punctata*.

Distribution.—Hamilton described this species from the rivers of the northern parts of Bengal, but Day noted "Rivers of Northern Bengal, not uncommon in the Jumna at Delhi, and also found at Poona in the Deccan". The two specimens we have referred to *G. viridescens* are from Bengal and Assam respectively and we doubt whether the range of this species extends to the Deccan.

Measurements in millimetres.

	Tezpur, Assam.	Barakar, Santal Parganas.
Standard length	75·0	44·5
Length of head	25·0	14·0
Height of head at occiput	14·0	8·5
Width of head	19·0	11·0
Length of snout	10·5	5·5
Diameter of eye	6·0	4·0
Interorbital width	6·0	4·0
Depth of body	16·5	10·0
Length of caudal peduncle	9·0	6·0

Measurements in millimetres.

	Tezpur, Assam.	Barakar, Santal Parganas.
Least height of caudal peduncle ..	5·5	3·5
Longest ray of dorsal	15·5	8·0
Length of dorsal spine	9·5	6·5
Length of pectoral	18·0	12·5
Length of pectoral spine	16·0	11·0
Length of ventral	12·0	7·0
Longest ray of anal	14·5	8·5
Length of base of anal	9·0	6·5
Length of base of adipose dorsal ..	9·5	6 5

Gagata nangra (Hamilton).

Plate I, figs. 9, 10.

1822. *Pimelodus nangra*, Hamilton, *Fish. Ganges*, pp. 193, 378, pl. xi, fig. 63.
1854. *Pimelodus nangra*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
1871. *Macrones nangra*, Day, *Proc. Zool. Soc. London*, p. 288.
1877. *Nangra buchanani*, Day, *Fish. India*, p. 494, pl. cxiii, fig. 3.
1889. *Nangra buchanani*, Day, *Faun. Brit. Ind. Fish.* I, p. 211.

D. 2/9-10 ; A. 3/10 ; P. 1/9 ; V. 1/5 ; C. 16-17.

Gagata nangra is a small and slender species in which the dorsal profile is slightly arched, while the ventral profile is horizontal in front of the pelvic fins and thence rises gradually to the tail. The body is compressed from side to side, more so in the tail region. The ventral surface of the head and the anterior part of the body are flattened.

The head is sharp, long and oval; its length is contained from 3·83 to 4·18 times in the standard length. The height of the head is contained 2·0 times and its width from 1·06 to 1·50 times in its length. The snout is long and pointed, and projects in front of the mouth for a considerable distance. The eyes are relatively small and dorso-lateral in position; they are not visible from the ventral surface. The diameter of the eye is contained from 5·38 to 6·00 times in the length of the head, 1·20 times in the length of the snout and from 1·20 to 1·33 times in the interorbital width. The two nostrils of each side are well marked and are placed nearer the tip of the snout than the eye. The median groove on the head is broad and extends from between the nostrils to the base of the occipital process; the lateral edges of the groove are raised into slightly elevated longitudinal ridges. At the sides of the groove in the posterior region of the head there are two pairs of fontanels. The occipital process is broad and long; it is almost twice as long as broad at the base and almost extends to the basal bone of the dorsal fin. The mouth is inferior, crescentic and horizontal; its width is almost equal to the length of the snout. The lips are visible as definite structures only near the angles of the mouth. The teeth are minute and in the upper jaw are situated outside the mouth. There are four pairs of barbels; the nasal barbels are almost as long as the head; the maxillary barbels are provided with stiff basal parts and extend to the anal fin or beyond; the outer mandibular barbels are more than one and a half times as long as head while the inner pair is equal to the head behind the nostrils. The bases of the inner pair of mandibular barbels are situated in front of those of the outer pair. The gill-openings are wide

and on the ventral surface extend anteriorly to the median line; the gill-membranes are united with each other.

The depth of the body is contained from 6·90 to 8·37 times in the standard length. The least height of the caudal peduncle is contained from 2·20 to 2·75 times in its length. The portion of the body where the air-bladder comes in contact with the skin is not well marked externally. The cubito-humeral processes are, however, well developed.

The commencement of the dorsal fin is situated well in advance of that of the pelvics, but its base extend over the pelvic fins; its longest ray is greater than the head but the spine is somewhat shorter. The dorsal spine is a strong prickle which is smooth along both the edges. The adipose dorsal is short but well marked. The paired fins are horizontally placed. they are somewhat shorter than the head and are separated from the pelvic fins by a considerable distance. The pectoral spine is strong and broad; it is smooth along the outer border but is strongly denticulated internally. The pelvic fins are long and pointed; they extend beyond the anal opening but do not reach the base of the anal fin. The caudal fin is deeply forked with both the lobes sharply pointed.

Hamilton noted that the colours of *Gagata nangra* " are rather agreeable, being silver, with some green on the back, and a faint brown streak across the foremost back fin, and another across the fin of the tail". According to Day, the colour is " muddy, with three indistinct vertical greenish half bands". In the specimens examined by us, there is a short, faint longitudinal band below the base of the dorsal fin and another along the lateral line. There is a vertical bar at the base of the caudal fin and the dorsal surface of the head is dusky.

Distribution.—Hamilton found this species in the Kosi river, but Day extended its range to the Ganges, Jumna and Indus. The two specimens of *G. nangra* examined by us were collected from the river Hooghly at Nawabgunj.

This species can be readily distinguished by its longer barbels, pointed snout and extensive gill-openings.

Measurements in millimetres.

Standard length	33·5	34·5
Length of head	8·0	9·0
Height of head at occiput	4·0	4·5
Width of head	7·5	6·0
Length of snout	1·8	1·8
Diameter of eye	1·5	1·5
Interorbital width	1·8	2·0
Depth of body	4·0	5·0
Length of caudal peduncle	5·5	5·5
Least height of caudal peduncle	2·0	2·5
Longest ray of dorsal	9·0	10·0
Length of dorsal spine	7·0	8·0
Length of pectoral	6·8	8·0
Length of pectoral spine	5·2	6·5
Length of ventral	6·0	6·8
Longest ray of anal	7·4	9·5
Length of base of anal	5·0	5·0
Length of base of adipose dorsal	5·5	7·0

X. FISHES OF THE GENUS *Batasio* BLYTH.

In the preceding article of this series, attention is directed to the fact that considerable confusion prevails regarding the taxonomic validity and the generic limits of *Batasio* Blyth, and reference has been made to the more salient features by which it can be distinguished from the superficially allied genus *Gagata*. In this article we give a detailed historical and taxonomic account of the genus, and descriptions of the species which we assign to it. A new species of *Batasio* has been discovered from Travancore, S. India, and the range of one of the Indian species, *B. tengana*, has recently been extended by Hora and Gupta[1] to the Malay Peninsula. These new records of the distribution of the genus from such widely separated localities are very significant from a zoogeographical point of view and lend considerable support to the hypothesis advanced by one of us[2] that the similarity in the fish-fauna of the Malay Region and of South India is due to the migration of the southern Chinese fishes to both the regions along mountain ranges at a time when the geographical features of these countries were different from what they are to-day. The migration of *Batasio* from Burma and Assam to Travancore was probably along the old Satpura trend of mountains as far as the Western Ghats and thence along the Ghats to the south of the Peninsula.

Batasio Blyth.

1860. *Batasio*, Blyth, *Journ. As. Soc., Bengal* XXIX, p. 149.
1862. ? *Batasio*, Bleeker, *Atl. Ichthyol.* II, p. 9.
1863. ? *Batasio*, Bleeker, *Ned. Tijds. Dierk.* I, p. 94.
1921. *Macronoides*, Hora, *Rec. Ind. Mus.* XXII, p. 179 (1921).

In 1860, Blyth[3] established the genus *Batasio* to accommodate a group of Bagroid fishes and characterised it as follows :—

"A Bagroid form well worthy of distinction; comprising a number of small species with round and prominent muzzle, and the contracted mouth opening from below : with eight, or sometimes (?) six, cirri, which are very short, the maxillary cirri scarcely passing the eye in some. Palatal band of teeth continuous with the mass of maxillary teeth, or separated only by a slight groove. Rest as in *Bagrus* (*verus*).

"Type. *B. Buchanani*, nobis; *Pimelodus batasio*, H. B."

Blyth did not examine any specimen of Hamilton's[4] *Pimelodus batasio*, but described a new species, *B. affinis*, from Tenasserim. He observed that :—

"To the same type, but with shorter adipose dorsal, appertain the *tengana*, *chandamara* and *rama* of Buchanan Hamilton. *B. chandamara* is referred to *Silundia* by M. Valenciennes, and is described by Hamilton to have only two cirri; but his unpublished figure represents six cirri distinctly, and in all this group the minute cirri are discernible with difficulty and are extremely liable to be overlooked. To *Bagrus capenses* of Sir A. Smith's 'Illustrations of S. African Zoology' would appear also to be referable to this particular division."

Bleeker[5] considered *Batasio* a doubtful genus, but assigned it to the phalanx *Bagrichthyes* and stirps Bagrini. Günther[6] evidently regarded

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[1] Hora, S. L. and Gupta, J. C., *Bull. Raffles Mus. Singapore*, No. 17 (1941).
[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 255, 256 (1937); *Proc. Nat. Inst. Sci. India* IV, p. 405 (1938).
[3] Blyth, E., *Journ. As. Soc. Bengal* XXIX, pp. 149, 150 (1860).
[4] Hamilton, F., *Fish. Ganges*, p. 179 (Edinburgh, 1822).
[5] Bleeker, P., *Ned. Tijds. Dierk.* I, p. 94 (1863).
[6] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 83 (1864).

it as a synonym of *Macrones*, for he described both *Pimelodus batasio* Ham. and *Batasio affinis* Blyth in this genus. Day[1] included it under *Gagata* and remarked in a footnote as follows:—

> "Genus *Batasio*, Blyth, is said to comprise fishes with the barbels shorter than the head and teeth on the palate. examples: *Pimelodus batasio*, H. B. (*the* author merely says of the teeth, that those 'in both jaws are crowded'), *P. tengana*, H. B., *B. affinis*, Blyth, *P. rama*, H. B. The two first probably belong to genus *Gagata*, the third to *Macrones*, and the last two to *Liocassis*."

Vinciguerra[2] discussed the systematic position of *Batasio* in regard to *Macrones* and other allied Bagrid genera, but did not consider it distinct from *Macrones*. He described a new species *M. dayi* from Meetan and Toungoo which is stated to be closely allied to *Batasio affinis* Blyth.

Jordan in his 'Genera of Fishes' (p. 294) stated that *Batasio* Blyth replaces *Gagata* Bleeker. In view of the confused taxonomic position of *Batasio*. one of us (S. L. H.) did not realize its generic limits when he created the subgenus *Macronoides*[3] for *Macrones affinis* (Blyth), *M. dayi* Vinciguerra and *M. marianiensis* Chaudhuri.[4] *Macronoides* was characterised as follows:—

> "This new subgenus is proposed for species which differ from typical *Macrones* in the possession of a distinct ventral mouth bordered by fringed lips; in having short barbels not exceeding the length of the head; in the mandibular pairs of barbels being disposed in a transverse row across the mandible and in the possession of open pores on the ventral surface of the head just behind the mouth. In general facies the fish of this subgenus show a remarkable resemblance to those of the genus *Gagata*, from which, however, they are easily distinguished by the crescentic band of teeth and a free air-bladder in the abdominal cavity."

In examining the collection made by Messrs. G. E. Shaw and E. O. Shebbeare from the Terai and Duars, one of us (S. L. H.) found representatives of Hamilton's little known species—*Pimelodus batasio*—and found it to belong to his genus *Macronoides*. He, therefore, suggested to Shaw & Shebbeare[5] to revive Blyth's genus *Batasio* and to describe this fish as *Batasio batasio* (Hamilton).

Having cleared the systematic position of *Batasio* Blyth from a study of the fresh material of *B. batasio* (Ham.) obtained from its type-locality, we may now consider which other species can be assigned to this genus. We have indicated above (*vide supra*, p. 13) that Hamilton's *Pimelodus tengana*,[6] as surmised by Blyth already (*vide supra*, p. 28), belongs to this genus. In a recent collection made by one of us (S. L. H.) from the Terai and Duars there are several specimens which are referable to this species, though the colouration, which is variable, differs from that described by Hamilton. He observed that:—

> "..........The body is diaphanous, with a silver *coloured membrane* investing the viscera and spine, and with a gloss of gold on the sides. On the back are many black dots, which are collected into a spot above each pectoral fin, and also on the crown of the head. The fins of the back and tail also are dotted, so that the edge of the last is black, and several spots are formed on the first."

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[1] Day, F., *Fish. India*, p. 492 (1877).

[2] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, pp. 211-217, 230-235 (1890).

[3] Hora, S. L., *Rec. Ind. Mus.* XXII, p. 179 (1921).

[4] Chaudhuri, B. L., *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1*a*, 1*b* (1913).

[5] Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, pp. 97, 98, text-fig. 98, 1937 (1938).

[6] Hamilton, F., *Fish. Ganges*, p. 176, pl. xxxix, fig. 58 (Edinburgh, 1822).

Hamilton found this species in the Brahmaputra river at Goalpara. In the adult specimens from the Terai and Duars the colouration is more or less similar to that described by Hamilton but in the younger specimens the body is marked with a few oblique bands and spots, and the distal half of the anterior rays of the dorsal fin is black. On the whole the colour seems to vary considerably with age (*vide infra*, p. 38).

In describing *Batasio affinis*, Blyth[1] remarked :—

> " Exceedingly like *B. Buchanani*, as described by Buchanan Hamilton and as figured in one of his unpublished coloured drawings ; whereas his published figure (F. G. pl. xxiii, f. 60) refers to his *Pimelodus carcio*, which is a true *Bagrus* with moderately long maxillary cirri :—but having 12 instead of 16 anal rays, no distinct longitudinal black stripe on each side of the body, but a tendency to show three or four black broad cross-bands, more or less distinct, besides a round black spot near the gill-covers, as in the other. The first dark band proceeds obliquely downwards from the fore-part of the first dorsal, to some distance below the lateral line ; and posterior to this first band are obscure traces of three or four others, the last at base of tail. On the membrane of the dorsal fin is a large blackish spot, consisting of minute dark specks."

The type of Blyth's species is preserved in the collection of the Indian Museum, and though its colouration has faded there can be no doubt of its identity with the specimen of Hamilton's *Pimelodus tengana* from the Tista River System.

In his 'Supplement' to the 'Fishes of India' (1888, p. 805), Day described *Leiocassis fluviatilis*, a species of freshwater fish found by Day in Col. Tickell's " volume of beautiful coloured drawings of Burmese Fishes with their descriptions ", of which Col. Tickell is stated to have " obtained four examples, the largest 3½ inches long from the Anin, a steam rising near Weywoon, Wagroo in the Tenasserim Provinces ". The identity of this species is still in doubt, but recently Hora and Gupta examined six specimens from the Chenderoh Lake, Perak, in the collection of the Raffles Museum, Singapore, which they referred to this species. The most characteristic feature of *L. fluviatilis* is its colouration, which, according to Day (*loc. cit.*), is as follows :—

> " Yellowish horny with darker shades of olive brown on the snout and along the back, also some cloudy markings. A large black blotch on the lateral-line above the anal fin, another between the pectoral and first dorsal. Tip of dorsal and ends of both caudal lobes black."

In the examples from Perak the black blotch on the lateral line above the anal fin is very conspicuously marked, while the anterior blotch represents the area against which the air-bladder comes directly in contact with the skin. Another conspicuous feature of these examples is an oblique horseshoe-shaped band lying in front of the first dorsal fin and descending on the sides to below the lateral line. Sometimes this band breaks up into a dorsal blotch and two oblique bars on the sides. There is a submarginal band on the dorsal fin and the tips of the caudal fins are somewhat dusky but not black.

Day observed that with the exception of the maxillary pair of barbels no others were detected. We find that there are two pairs of mandibular barbels, the outer being more or less equal to the diameter of the eye while the inner are very rudimentary. The nasal barbels extend

[1] Blyth, E., *Journ. As. Soc. Bengal* XXIX, p. 149 (1860).

to the front border of the eye or slightly beyond it. The maxillary barbels, as noted by Day, extend as far as the posterior border of the orbit.

A comparison of the Perak examples with those of *Pimelodus tengana* from the Eastern Himalayas and of *Batasio affinis* from Tenasserim leaves little doubt of their identity. We are, therefore, led to conclude that Day's *Leiocassis fluviatilis* is a synonym of *Batasio tengana* (Ham.).

Vincigeurra's[1] *Macrones dayi* is stated to be closely allied to *Leiocassis fluviatilis* Day and *Batasio affinis* Blyth, only differing in proportions and colouration. From a study of a large number of specimens we have found that such differences have no specific value and we are of opinion, therefore, that *M. dayi* is also a synonym of *Batasio tengana* (Ham.). Chaudhuri's[2] *M. mariamiensis*, described from the Brahmaputra River System, Assam, and later recorded from the streams at the base of the Eastern Himalayas, is also a synonym of *B. tengana*. The species described and figured by Shaw and Shebbeare[3] as *Leiocassis rama* is also referable to *B. tengana*. Regarding this species Shaw and Shebbeare noted :—

> "In general appearance resembles those species of *Mystus* which have a shoulder-blotch and longitudinal bands but has much shorter barbels. It therefore somewhat resembles *Batasio batasio* from which it is distinguished by having a shorter adipose fin and a longer anal."

Recently we obtained a number of specimens from Travancore in which the body is of deep gray colour and is devoid of any transverse oblique bands or spots. These specimens are of a somewhat larger size and on morphological characters represent a new species of *Batasio*. In the present-day discontinuous distribution of this genus we have another record of the common origin of the fauna of the Malay Peninsula and that of Peninsular India.

Besides *Batasio batasio* (Ham.) and *B. tengana* (Ham.), there are two other species of Hamilton's *Pimelodus* which have been assigned by Blyth to *Batasio*, *viz.*, *P. chandramara* and *P. rama*. Hamilton[4] recognised the great similarity between these species and separated them on the following characters :—

P. chandramara.	*P. rama.*
1. Two barbels.	1. Six barbels.
2. Diaphanous with clusters of black dots; golden stripe along lateral line.	2. Diaphanous, yellowish without dots. Black spot on nape, divided into four lobes.
3. A. 17.	3. A. 15.

As pointed out by Blyth, Hamilton's original figure of *P. chandramara*[5] shows six distinct barbels. The other two points of difference are not of specific value as the colour may vary according to habitats

[1] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 230 (1890).
[2] Chaudhuri, B. L., *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1a, 1b (1913).
[3] Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, p. 90 text-fig. 88, pl. 3, fig. 4, 1937 (1938).
[4] Hamilton, F., *Fish. Ganges*, pp. 162, 176 (Edinburgh, 1822).
[5] *Vide* Hora, S. L., *Mem. Ind. Mus.* IX, pl. xxi, fig. 6 (1929).

and the difference in the number of anal rays may be due to individual variation. Both the species were described from Northern Bengal.[1]

Hamilton's descriptions of both the species are brief and inadequate for their specific determination, and, as pointed out by Blyth (*loc. cit.*), there are discrepancies between his descriptions and figures. For instance, Hamilton stated in his description that *P. chandramara* possesses only "two tendrils", whereas in his unpublished figure 6 barbels are distinctly shown. The consideration of the number of barbels alone seems to have led Swainson[2] and Cuvier & Valenciennes[3] to refer *P. chandramara* to the genera *Silonia* and *Silundia* respectively. It may be stated without any fear of contradiction that Hamilton's species does not belong to either of these genera. Blyth placed it in the genus *Batasio* but without examining any specimen of the species; his conclusion seems to have been based on a study of the unpublished drawing of the species. In the two species of *Batasio* referred to above, there is a distinct nasal barbel, which is neither described nor shown in the figure of *Pimelodus chandramara.* Günther[4] referred *P. rama* very doubtfully to the genus *Rita*, but considering the large size of its eyes, general facies and habitat, it is difficult to place it among *Rita.* Day[5] examined a specimen from Assam, which undoubtedly belongs to this species and regarded it as *Leiocassis.*[6] On a careful analysis of Day's description it is found that the species shows affinities with both *Batasio* and *Leiocassis.* For instance, the subcutaneous nature of the eyes is a character of *Leiocassis*, but their relatively large size is a character of *Batasio.* The absence of the nasal barbels, however, precludes it from either of the genera. We have examined Day's specimen from Assam, which is in a poor state of preservation, and have found open pores along the lower jaw and edges of the gill-covers which are characteristic of *Batasio.* In view of what is stated above, and in the absence of good and reliable material it is perhaps desirable to keep *Pimelodus rama* in a separate genus for which Bleeker has already proposed the name *Rama.*

In 1931, H. M. Smith[7] described from Siam a strikingly marked little catfish and referred it to the genus *Mystus.* The colouration and general build of this species, *M. havmolleri*, are very similar to

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[1] Day (*Fish. India*, p. 452, 1877) notes that "In Ham. Buch. MSS. *P. chandramara* is said to be found in the Rangpur district in the Mahánandá and also in the Dinajpur district. In Purniah he records it as termed Thŭnka-pátasĭ of the Kusí and Khámaĭŭ at Bholáhát. In the 'Fishes of the Ganges', he remarks that *P. rama* is from the Brahmaputra. The fish I have here described from the same locality, appears to be a link between the two forms, as the Assam one is said to have on nape a large black spot divided into four lobes, and which is not present in my specimens, which it is said to differ from *P. chandramara.* chiefly in the latter being deficient in this mark. I have referred my specimen to *P. rama* as it came from Assam.

[2] Swainson, W., *Nat. Hist. Classification Fish. Amph. Rept.* II, p. 305 (1839).

[3] Cuvier, G. and Valenciennes, A., *Hist. Nat. Poiss.* XV, p. 49 (1840).

[4] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 92 (1864).

[5] Day, F., *Fish. India*, p. 451 (London, 1877).

[6] Regan [*Ann. Mag. Nat. Hist.* (8) II, p. 547, 1913] observed that "*Pimelodus rama* Ham. Buch., from Bengal and Assam, is placed by Day in *Liocassis* (*Fish. India*, p. 451 pl. cxv, fig. 2); it seems improbable that this little fish really belongs to the genus; but if it does, the large eye and minute mandibulary barbels distinguish it from all the other species".

[7] Smith, H. M., *Proc. U. S. Nat. Mus.* LXXIX, Art. 7, p. 24, fig. 24 (1931).

Batasio tengana. though in the size of its eyes, barbels and adipose dorsal it is somewhat different. It is stated to be provided with "a transverse row of 4 large pores behind lower lip; entire snout thickly beset with minute pores". A more detailed description of the species is necessary to determine its precise specific limits but there can hardly be any doubt of its position in the genus *Batasio*. In fact, its resemblance to *B. tengana* is so close that, in the present state of our knowledge we consider that the differences between the two are not of specific value.

From the above it will be clear that in the present state of our knowledge only three Indian species can definitely be assigned to the genus *Batasio*. These can be distinguished by the following key:—

Key to the Indian species of Batasio *Blyth.*

A. Base of adipose dorsal considerably longer than that of anal.
- I. Body marked with longitudinal bands; a conspicuous dark spot above pectoral. [Median groove on head continued on occipital process for some distance; occipital process extending over basal bone of dorsal and meeting first dorsal spine; no pores on dorsal surface of head.] .. .. *B. batasio.*
- II. Body without longitudinal bands or spots. [Median groove on head extending to base of occipital process; occipital process separated from basal bone of dorsal fin by a considerable distance; pores on dorsal surface of head present] .. .. *B. travancoria.*

B. Base of adipose dorsal shorter or equal to base of anal. [Median groove on head extending to end of occipital process and in its posterior portion containing basal bone of dorsal fin; no pores on dorsal surface of head; body marked with oblique vertical bands or spots.] .. .. *B. tengana.*

Batasio batasio (Hamilton).

Plate II, figs. 4-6.

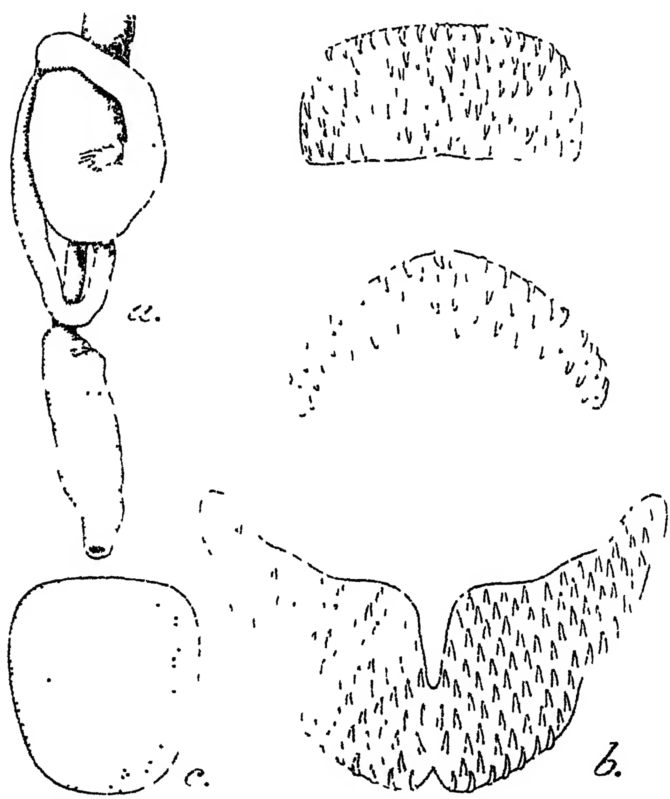
1822. *Pimelodus batasio*, Hamilton, *Fish. Ganges*, pp. 179, 377. (The drawing on pl. xxiii, fig. 60 does not refer to this species, but to *P. carcio* described on p. 181).
1839. *Bagrus batasio*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* XIV, p. 425.
1860. *Batasio Buchanani*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1862. ? *Batasio Buchanani*, Bleeker, *Atl. Ichthyol.* II, p. 8.
1863. ? *Batasio Buchanani*, Bleeker, *Ned. Tijdschr. Dierkund.* I, p. 94.
1864. *Macrones batasio*, Gunther, *Cat. Fish. Brit. Mus.* V, p. 83.
1877. *Gagata batasio*, Day, *Fish. India*, p. 493, pl. xcix, fig. 5 (Hamilton's MS. drawing reproduced).
1889. *Gagata batasio*, Day, *Faun. Brit. Ind. Fish.* I, p. 209.
1929. *Pimelodus batasio*, Hora, *Mem. Ind. Mus.* IX, pl. xxii, fig. 3.
1938. *Batasio batasio*, Shaw and Shebbeare, *Journ. Roy. As. Soc. Bengal, Science* III, p. 97, fig. 98.

D. 2/7; A. 3-4/9-10; P. 1/5-8; V. 1/5; C. 17.

Batasio batasio is a medium-sized species in which the dorsal and the ventral profiles are moderately arched. The dorsal profile rises gradually from the tip of the snout to the origin of the dorsal fin whence it slopes down gradually to caudal peduncle where it is horizontal. The ventral profile is horizontal and flattish just for a short distance between the head and pelvic fins, thence it rises gradually towards

both ends. The body is compressed from side to side, more so in the tail region.

The head is sharp, bluntly pointed and conical; its length is contained from 3·61 to 3·90 times in the standard length. The height of the head is contained from 1·34 to 1·71 times and its width from 1·43 to 2·38 times in its length. The snout is fairly long and pointed; it projects in front of the mouth for a short distance. The eyes are of a moderate size and dorso-lateral in position; they are not visible from the ventral surface. The orbital margins are free. The diameter of the eye is contained from 2·63 to 3·30 times in the length of the head, from 1·14 to 1·53 times in the length of the snout and from 0·71 to 1·20



Text-fig. 2.—Alimentary canal, dentition and air-bladder of *Batasio batasio* (Hamilton).

a. Alimentary canal: ×2½. *b.* Dentition: ×12. *c.* Air-bladder: ×2½.

times in the interorbital width. The two nostrils of each side are wide apart and are not so conspicuous as in the species of *Gagata*. The anterior nostril is placed above the base of the maxillary barbel and much nearer the tip of the snout than the eye; while the second pair is closer to the eye than to the anterior nostril. The median groove on the head is long and narrow; it extends from between the posterior nostrils to one-third of the occipital process; the lateral edges of the groove are slightly raised into longitudinal ridges. In the groove,

there are two fontanels which are separated by a broad bony ridge; the anterior fontanel extends over the anterior two-thirds of the eye, while the posterior fontanel commences from behind the eye and extends for a short distance over the occipital process. The occipital process is long and broad; its length is almost 3½ times its width at the base; it extends over the basal bone of the dorsal fin. The mouth is inferior, crescentic and horizontal; it is bordered by fleshy lips which are continuous at the angles of the mouth. The labial groove is broadly interrupted in the middle: both the lips are distinctly fimbriated. Behind the lower lip there are four slit-like openings and four pairs of pores on the ventral surface of head running obliquely from the mandibular barbels to the gill-openings. The teeth are small and villiform; they are arranged in broad continuous bands in the jaws and in a similar band on the palate. There are four pairs of barbels; the nasal barbels, which are placed at the anterior end of the posterior nostrils, are small and considerably shorter than the diameter of the eye; the maxillary barbels do not extend beyond the posterior margin of the orbit and the mandibular barbels are still shorter; the bases of the latter are not situated exactly in a transverse line behind the lower lip, but those of the inner pair are slightly in advance of those of the outer. The gill-membranes are notched anteriorly and the gill-openings are very extensive.

The depth of the body is contained from 3·72 to 4·40 times in the standard length. The least height of the caudal peduncle is contained from 1·33 to 1·57 in its length. The portion of the body where the air-bladder comes in contact with the skin is well marked externally. The cubito-humeral processes are also well developed. The external features of the urino-genital organs are similar to those as described above in the species of *Gagata* (*vide supra*, p. 16). In ripe males the urinogenital papilla is well marked.

The rayed dorsal fin is situated well in advance of that of the pelvics, but its base extends almost over the pelvic fins; its longest ray is shorter than the length of the head and the spine is much shorter. The dorsal spine is a strong prickle which is smooth along both the borders. The adipose dorsal is considerably long and well marked; the length of its base is equal to or greater than the length of its head. The pectoral fins are horizontally placed and are shorter than the head; they are separated from the pelvic fins by a considerable distance. The pectoral spine is strong and broad; it is smooth along the outer border but is strongly denticulated internally. The pelvic fins extend beyond the anal opening but do not reach the base of the anal fin. The caudal fin is deeply forked with both the lobes sharply pointed.

Hamilton noted that the fish is provided "with a diaphanous body, having on each side two stripes dotted with black .... The cavity containing the viscera is lined with a silver *coloured* membrane; and, besides the two stripes, the fish has on each shoulder a spot composed of black dots. The first dorsal fin is spotted, the second is dotted." Shaw and Shebbeare described the colouration as follows:—

"Leaden above, yellow beneath. A dark longitudinal band along the lateral line expanding into a shoulder-blotch immediately below the dorsal fin. A second fainter and somewhat curved dark band midway between the lateral line and the

dorsal ridge, commencing at the top of the opercle and ending about the middle of the adipose fin. It is connected with the dark colour of the dorsal ridge at the front part of the rayed dorsal."

Distribution.—*Batasio batasio* is known so far from the Tista River System. We have examined several specimens from the streams of Terai and Duars.

Measurements in millimetres.

Standard length	55·0	65·0	69·0	75·0	84·0	89·5
Length of head	14·5	18·0	19·0	20·5	21·5	23·0
Height of head at occiput ..	9·5	10·5	13·0	14·0	16·0	15·0
Width of head	9·0	10·0	12·5	13·8	9·0	16·0
Length of snout	6·5	7·5	8·0	8·0	10·0	10·0
Diameter of eye	5·5	6·0	7·0	7·0	6·5	7·0
Interorbital width	4·5	5·0	5·0	5·0	6·0	6·5
Depth of body	12·5	15·0	18·5	17·5	23·5	23·0
Length of caudal peduncle ..	8·0	9·0	11·0	11·0	12·5	12·0
Least height of caudal peduncle ..	5·5	6·5	7·0	8·0	8·5	9·0
Longest ray of dorsal ..	10·0	11·5	13·0	14·0	D.	14·5
Length of dorsal spine ..	9·0	12·0	9·5	12·0	D.	D.
Length of pectoral	11·0	12·0	14·0	13·0	14·5	14·0
Length of pectoral spine ..	10·0	11·0	12·0	D.	13·0	13·0
Length of ventral	8·5	12·0	10·0	11·0	10·5	13·0
Longest ray of anal	11·0	9·5	9·5	11·5	15·5	D.
Length of base of anal ..	10·5	10·0	12·0	11·5	14·5	11·0
Length of base of adipose dorsal .	19·0	16·5	19·0	22·0	21·5	23·0

Batasio tengana (Hamilton).

Plate II, figs. 1-3.

1822. *Pimelodus tengana*, Hamilton, *Fish. Ganges*, pp. 176, 377, pl. xxxix, fig. 58.
1839. *Bagrus tengana*, Cuvier & Valenciennes, *Hist. Nat. Poiss.* XIV, p. 433.
1854. *Bagrus tengana*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1860. *Batasio affinis*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1860. *Batasio tengana*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1864. *Macrones affinis*, Günther, *Cat. Fish. Brit. Mus.* V, p. 83.
1864. *Macrones tengana*, Günther, *Cat. Fish. Brit. Mus.* V, p. 84.
1873. *Macrones affinis*, Day, *Proc. Zool. Soc. London*, p. 111.
1877. *Macrones Blythii*, Day, *Fish. India*, p. 445.
1877. *Gagata tengana*, Day, *Fish. India*, p. 493.
1888. *Leiocassis fluviatilis*, Day, *Fish. India Suppl.*, p. 805.
1889. *Liocassis fluviatilis*, Day, *Faun. Brit. Ind. Fish.* I, p. 164.
1889. *Macrones blythii*, Day, Faun. *Brit. Ind. Fish.* I, p. 151.
1889. *Gagata tengana*, Day, *Faun. Brit. Ind. Fish.* I, p. 210.
1890. *Macrones Dayi*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 230, pl. vii, fig. 3.
1913. *Macrones marianiensis*, Chaudhuri, *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1*a*, 1*b*.
1921. *Macrones* (*Macronoides*) *affinis*, Hora, *Rec. Ind. Mus.* XXII, p. 180.
1921. *Macrones* (*Macronoides*) *merianiensis*, Hora, *Rec. Ind. Mus.* XXII, p. 736.
1931. *Mystus havmolleri*, H. M. Smith, *Proc. U. S. Nat. Mus.* LXXIX, art. 7, p. 24, fig. 12.
1937. *Leiocassis rama*, Shaw & Shebbeare (*nec* Hamilton), *Journ. Roy. Asiat. Soc. Bengal*, *Science* III, p. 90, text-fig. 88, pl. iii, fig. 4.

D. 2/7-8; A. 3-4/8-11: P. 1/7-9; V. 1/5; C. 16-18.

Batasio tengana is a small, well-built species in which both the dorsal and the ventral profiles are somewhat arched; the body is deepest about the commencement of the dorsal fin and from that point it tapers both anteriorly and posteriorly. The ventral surface between the pectorals is only slightly flattened, but that of the head is flat-ish. The fish is compressed from side to side; this is more marked in the tail region.

The head is broadly pointed anteriorly and the snout is produced beyond the mouth for a short distance. The length of the head is contained from 3·58 to 4·17 times in the standard length: the height of the head is contained from 1·35 to 1·78 times and its breadth from 1·36 to 1·70 times in its length. The eyes are of a moderate size and are dorso-lateral in position; they are not visible from the ventral surface, and are situated almost in the middle of the length of the head. The diameter of the eye is contained from 2·50 to 3·40 times in the length of the head and from 0·87 to 1·4 times in the length of the snout. The interorbital distance is considerably less than the diameter of the eye. The nostrils are situated wide apart; the anterior nostril is tubular and directed forwards; the posterior nostril is situated almost midway between the eye and the tip of the snout and is provided with a nasal barbel at its anterior end. The median groove on the head is long and narrow; it extends from behind the posterior nostrils to the end of the occipital process; its margins form slightly elevated ridges. In the groove, there are two median fontanels which extend to the base of the occipital process and are separated from each other by a narrow ridge situated behind the eyes. The anterior part of the basal bone of the dorsal fin is lodged in the median groove of the occipital process. which is long and narrow. The mouth is small, inferior. horizontal and crescentic; it is bordered by fleshy lips which are continuous and pendulous at the corners of the mouth. The labial groove is broadly interrupted in the middle; both the lips are distinctly fimbriated. Behind the lower lip there are five slit-like oval openings and four pairs of small round holes situated obliquely between the bases of the mandibular barbels and the gill-openings. The teeth are small and villiform; those in the jaws form oval patches while those on the palate form a lunate band. There are four pairs of barbels; the nasal barbels extend to the anterior border of the orbit or a little farther; the maxillary barbels are the longest but are just about half the length of the head and the mandibular barbels are considerably shorter. The bases of the mandibular barbels are situated at a considerable distance behind the mouth and are not in a straight line, those of the inner pair being somewhat in advance of those of the outer. The gill-openings are very extensive and the gill-membranes are deeply notched anteriorly.

The depth of the body is contained from 3·69 to 4·65 times in the standard length. The least height of the caudal peduncle is contained from 0·84 to 1·60 times in its length. The portion of the body where the air-bladder comes in contact with the skin is well-marked. The cubito-humeral processes are narrow and can be readily felt through

the skin. The external features of the urinogenital organs are similar to those of *Batasio batasio*.

The rayed dorsal fin is situated considerably in advance of the pelvic fins, but its base extends almost over their commencement. The longest ray of the dorsal fin is considerably shorter than the head and the spine is still shorter. The dorsal spine is a smooth, moderately strong prickle. The adipose dorsal, though well marked, is not so extensive as that of *B. batasio*; it commences considerably behind the rayed dorsal and its base is somewhat shorter than the head. The pectoral fins are situated slightly above the ventral surface of the body; they are much shorter than the head and are separated from the pelvic fins by a considerable distance. The pectoral spine is flattened and strong; it is smooth externally but strongly denticulated internally. The pelvic fins are shorter than the pectorals and extend beyond the anal opening but not as far as the urinogenital openings. The anal fin is situated below the adipose dorsal and its base is slightly longer than that of the rayed dorsal. The caudal fin is deeply forked, with the lower lobe somewhat better developed; both the lobes are bluntly pointed.

As indicated above (*vide supra*, p. 30), the colour varies considerably with the size of the specimens and locality. In fresh specimens collected from the streams of Terai and Duars, Tista River System, the general surface is gray-olivaceous which is deeper above and lighter below. The dorsal surface of the head is dark with an indication of a band in the region of the eyes; this band passes on the sides below the eyes but does not extend to the ventral surface. There is a broad black spot on the nape. Behind the head there is an oblique darkish band dorsally which extends to the sides and joins the black blotches in the region above the pectorals where the air-bladder comes in contact with the skin. The rest of the body is marked with five oblique, saddle-shaped bands of varying depth of colour which do not extend to the ventral surface, the first is at the commencement of the rayed dorsal fin, the second at its termination, the third below the anterior part of the adipose dorsal, the fourth below the posterior part of the adipose dorsal and the last in front of the base of the caudal fin. The distal portions of the anterior rays of the dorsal fin are dark and form a broad patch. The other fins are somewhat dusky. The colour variations consist in the suppression or intensification of some of these markings, but the general colour plan remains more or less similar. For this reason we have attached no significance to colour variations in recognising species established on this character alone.

Distribution.—Batasio tengana was originally described from the Brahmaputra river. We have examined several specimens from below the Darjeeling Himalayas, Assam, Tenasserim, Mergui and Perak. It is also found in Siam (Klong Thalerng, near Ronpibun, Peninsular Siam), from where it was described as *Mystus havmolleri* by H. M. Smith. In the Siamese examples the eyes are considerably smaller and the adipose dorsal relatively longer. As judged from the figure the barbels, especially the maxillary pair, appear to be somewhat longer. In view of these differences it may perhaps be desirable to regard *M. havmolleri* as a variety of *B. tengana*.

Measurements in millimetres.

	Bengal.										Assam				Tenasserim.	Tasing, Mergui Expedition.	Chenderoh Lake, Perak.	
Standard length ..	38·5	40·0	43·5	46·0	48·0	49·0	54·5	51·5	56·0	60·0	41·5	57·5	64·5	68·5	63·0	74·0	53·5	61·0
Length of head ..	10·5	11·0	11·0	12·5	11·5	13·0	15·0	14·5	13·5	15·0	10·0	15·5	16·5	17·5	16·5	20·5	11·0	17·0
Height of head at occiput ..	6·5	6·5	7·0	9·0	7·0	9·0	8·5	9·0	10·0	9·5	6·5	9·5	11·0	11·0	11·0	15·0	10·0	9·5
Width of head ..	7·0	7·0	7·0	8·0	7·0	9·5	9·5	9·5	9·5	10·0	6·5	9·8	12·0	11·5	11·5	14·5	10·0	10·0
Length of snout ..	3·5	4·0	4·0	4·5	4·0	5·0	5·5	5·5	5·0	6·0	4·0	5·5	6·0	6·0	5·5	8·5	6·0	7·0
Diameter of eye ..	4·0	3·5	3·5	4·0	3·5	4·5	4·5	4·5	4·5	4·5	4·0	5·0	5·0	5·5	6·0	7·0	5·0	5·0
Interorbital width ..	3·0	3·0	3·0	3·0	3·0	3·5	4·0	3·5	4·0	4·0	2·5	3·5	4·0	4·5	5·0	5·0	4·0	4·0
Depth of body	9·0	9·0	10·5	11·5	10·5	11·5	12·0	13·0	14·5	15·0	9·5	14·5	14·5	18·5	16·0	19·5	12·5	16·5
Length of caudal peduncle	5·0	6·5	8·0	8·0	8·0	6·5	8·0	7·0	11·0	10·5	6·0	9·0	10·0	10·0	7·0	9·0	5·5	7·5
Least height of caudal peduncle	4·5	5·0	5·0	5·7	5·5	5·5	6·5	6·0	7·0	7·0	4·0	6·0	7·5	8·5	7·8	8·0	6·5	6·5
Longest ray of dorsal ..	8·0	9·0	9·5	10·0	10·0	11·0	12·0	11·5	10·5	13·0	9·0	11·0	13·0	12·0	D.	16·0	10·0	11·5
Length of dorsal spine ..	6·5	7·0	7·0	8·5	7·5	8·0	9·0	9·0	9·0	10·0	5·5	8·0	10·0	9·5	9·5	9·5	7·0	7·0
Length of pectoral ..	8·5	9·0	10·5	8·5	10·5	9·0	11·5	11·0	12·0	10·0	9·0	10·5	14·5	14·0	11·0	17·0	12·0	11·5
Length of pectoral spine ..	7·5	9·5	8·0	8·0	8·5	8·0	9·0	8·5	9·5	D.	6·5	8·0	10·5	10·5	10·0	13·0	9·5	8·0
Length of ventral ..	6·5	6·5	8·0	7·5	7·0	6·5	8·0	10·0	9·0	9·5	6·0	9·0	10·5	9·5	9·5	12·0	9·0	9·5
Longest ray of anal ..	8·0	6·0	9·0	8·0	10·0	9·5	8·5	11·0	9·5	12·5	8·5	9·5	13·5	13·5	11·0	D.	10·0	10·5
Length of base of anal ..	6·0	6·5	6·0	7·0	6·5	8·0	7·0	8·5	7·0	10·5	5·5	8·5	10·0	10·0	9·0	12·0	8·0	6·0
Length of base of adipose dorsal.	8·5	10·0	7·5	10·5	12·5	9·5	13·0	12·0	11·5	14·0	7·0	10·5	14·0	17·5	13·5	22·5	13·5	16·0

Batasio travancoria, sp. nov.

Plate II, figs. 7-9.

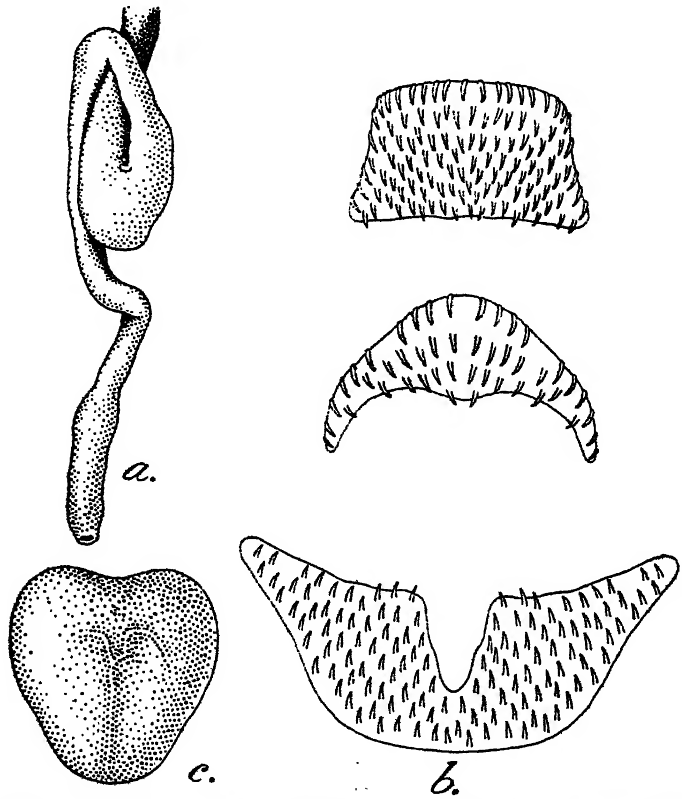
D. 2/7 ; A. 3-4/9-11 ; P. 1/7-9 ; V. 1/5 ; C. 16-19.

Batasio travancoria is an elongated, medium-sized fish, in which the dorsal profile is slightly arched while the ventral profile is more or less horizontal in front of the pelvic fins, after which it is slightly arched. The ventral surface of the head and the anterior part of the body are somewhat flattened. The fish is subcylindrical anteriorly and compressed posteriorly.

The head is globular, conical and rounded anteriorly; its length is contained from 3·87 to 4·35 times in the standard length. The height of the head is contained from 1·44 to 1·81 times and its width from 1·32 to 1·53 times in its length. The snout is rounded and projects beyond the mouth for a short distance; it is longer than the postorbital part of the head. The eyes are of a moderate size and are dorso-lateral in position; they are not visible from the ventral surface. The diameter of the eye is contained from 2·72 to 3·10 times in the length of the head, from 0·93 to 1·28 times in the length of the snout and from 0·50 to 0·81 times in the interorbital width. The nostrils are situated wide apart; the anterior nostrils are tubular and are directed forwards while the posterior nostrils are situated much nearer the eye than the anterior nostrils and are provided with nasal barbels. The median groove on the head is long and narrow; it extends from slightly in front of the posterior nostrils to the base of the occipital process or slightly farther and in it are lodged two fontanels separated by a narrow ridge. At the sides of the median groove there is a series of 3 small fontanels on either side. The occipital process is long and sharply pointed posteriorly; it is separated from the basal bone of the dorsal fin by a considerable distance. The mouth is small, inferior, lunate and horizontal; it is bordered by fleshy lips which are pendulous and continuous at the angles of the mouth; the labial groove is widely interrupted. The lips are slightly crenulate but not fimbriate as in the other two species. There are five large oval pores behind the lower lip and two series of six pores each situated obliquely between the angle of the mouth and the gill-cover. There are pores between the nostrils, below the eyes and along the free borders of the gill-covers. The teeth are small and villiform; they are arranged in bands in the jaws and on the palate. There are eight barbels; the nasal barbels are situated at the anterior border of the posterior nostrils and extend to about the middle of the eye; the maxillary barbels are short and do not extend beyond the eyes; the outer mandibular barbels are as long as the nasal barbels while those of the inner pair are much shorter. The bases of the mandibular barbels are not situated in a straight line; those of the inner pair are in advance of those of the outer. The gill-openings are extensive and the gill-membranes are notched anteriorly.

The depth of the body is contained from 4·86 to 5·48 times in the standard length. The least height of the caudal peduncle is contained from 1·01 to 1·29 times in its length. The portion of the body where

the air-bladder comes in contact with the skin is fairly well marked externally, and the cubito-humeral processes can be readily felt through the skin. The external features of the urinogenital organs are similar to those described for the other species. The urinogenital papilla is well marked, especially in the males.



Text-fig. 3.—Alimentary canal, dentition and air-bladder of *Batasio travancoria*, sp. nov.

a. Alimentary canal. ×*ca* 2½. *b.* Dentition: ×15. *c.* Air-bladder. ×2½.

The rayed dorsal fin is situated almost entirely in advance of the pelvics; its longest ray is considerably shorter than the head. The dorsal spine is comparatively weak and is slightly crenulated along both the borders; it is slightly longer than half the length of the head. The adipose dorsal commences as a slightly raised ridge behind the base of the rayed dorsal, but after the termination of the dorsal when laid flat it becomes a long, prominent ridge; the length of its base is considerably greater than the length of the head. The pectoral fin is considerably shorter than the head and is separated from the pelvics by about half of its length. The pectoral spine is moderately developed; it is smooth externally but denticulated internally. The pelvic fins are horizontal and extend considerably beyond the anal opening to the urinogenital papilla. The anal fin is low and the length of its base is almost equal to the base of the rayed dorsal fin. The caudal fin is

deeply forked with the lobes rounded; the lower lobe is better developed than the upper.

The colouration in spirit is uniformly gray with the exception of a narrow dark streak along the lateral line. The gray colour is somewhat deeper on the head and the dorsal surface and lighter on the side. The ventral surface is much lighter. All the fins are more or less dusky.

Distribution.—*Batasio travancoria* is represented in the collection of the Zoological Survey of India by five specimens, which were collected by Dr. C. C. John from the following localities in Travancore:

Locality.	No. of specimens.
Peruntenaruvi, a tributary of the Pamba R., at Edakadathy	1
Kolathupuzha, a tributary of the Kallada R.	2
Chittar R., Palode	1
Kallada R., 4 miles east of Thenmalai..	1

Type-specimen.—F. 13449/1, Zoological Survey of India (*Indian Museum*), Calcutta.

Measurements in millimetres.

Standard length	56·5	59·0	65·0	74·0	79·0
Length of head	14·5	15·0	15·5	17·0	20·5
Height of head at occiput	8·0	10 0	10·0	11·8	14·0
Width of head	10·0	9·8	11·2	12·8	14·5
Length of snout	5·0	5·7	6·4	6·5	7·0
Diameter of eye	5·2	5·5	5·0	5·5	7·5
Interorbital width..	3·8	3·0	4·0	4·5	3·7
Depth of body	11·5	11·5	12·0	15·2	14·5
Length of caudal peduncle	7·5	6·6	8·0	10 0	9·5
Least height of caudal peduncle ..	5·8	6·5	6·5	8·0	8·5
Longest ray of dorsal	11·3	12·0	12·4	14·0	15·0
Length of dorsal spine	8·5	9·0	9·5	10·0	10·5
Length of pectoral..	12·0	11·5	12·0	13·4	15·2
Length of pectoral spine	10·0	10·0	10·0	11·0	12·0
Length of ventral	9·0	10·0	11·0	12·0	12·5
Longest ray of anal	11·0	11·5	10·4	10·8	11·8
Length of base of anal	8·5	8·0	9·0	11·0	12·5
Length of base of adipose dorsal ..	21·0	17·8	22·8	24·0	30·5

EXPLANATION OF PLATE I.

Indian species of *Gagata* Bleeker.

Gagata gagata (Hamilton).

FIG. 1.—Ventral surface of head and anterior part of body. *Nat. Size.*
FIG. 2.—Dorsal surface of head and anterior part of body. *Nat. Size.*

Gagata itchkeea (Sykes).

FIG. 3.—Ventral surface of head and anterior part of body. $\times 2$.
FIG. 4.—Dorsal surface of head and anterior part of body. $\times 2$.

Gagata cenia (Hamilton).

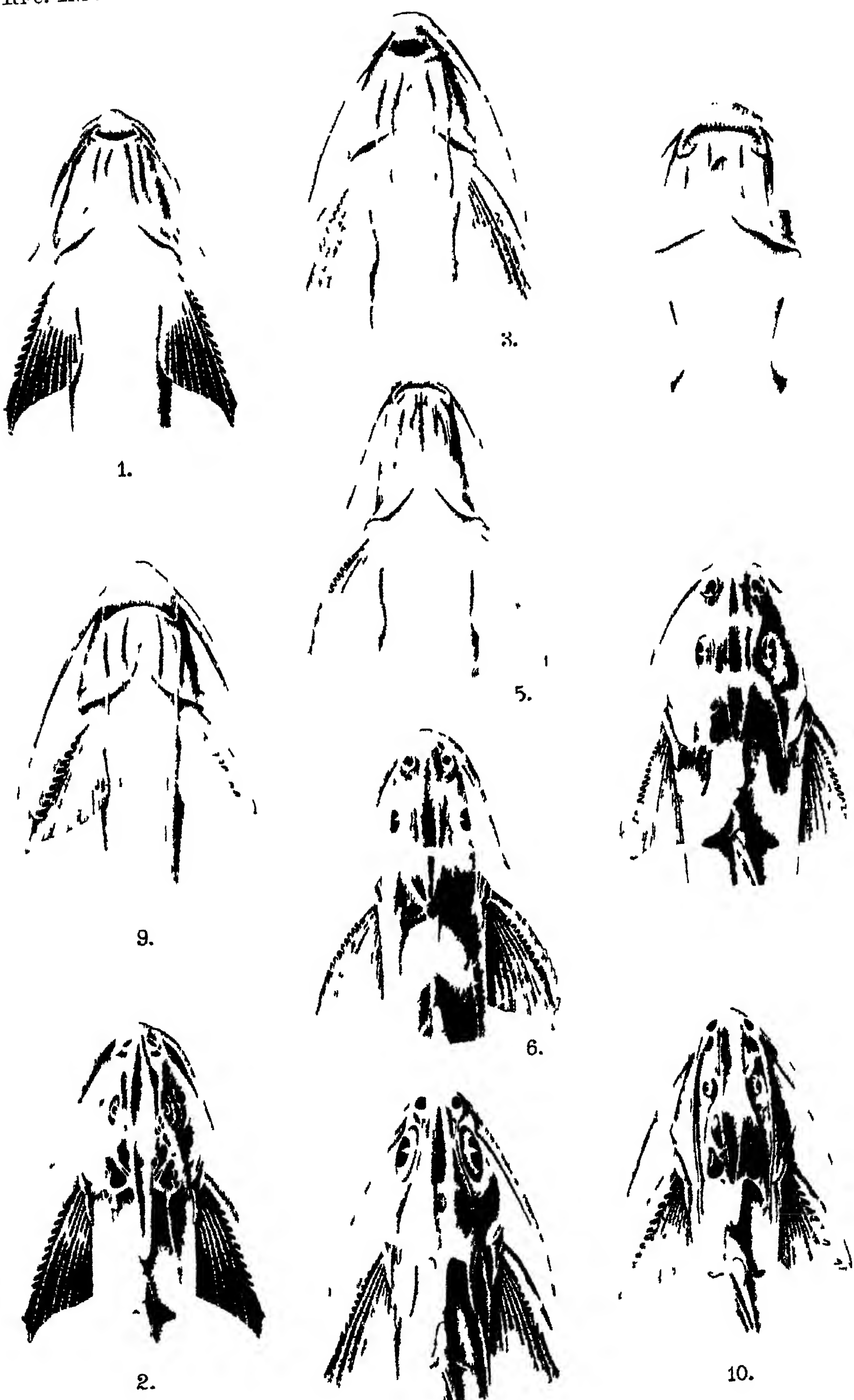
FIG. 5.—Ventral surface of head and anterior part of body. $\times 1\frac{1}{2}$.
FIG. 6.—Dorsal surface of head and anterior part of body. $\times 1\frac{1}{2}$.

Gagata viridescens (Hamilton).

FIG. 7.—Ventral surface of head and anterior part of body. $\times \frac{5}{8}$.
FIG. 8.—Dorsal surface of head and anterior part of body. $\times \frac{5}{6}$.

Gagata nangra (Hamilton).

FIG. 9.—Ventral surface of head and anterior part of body. $\times 3$.
FIG. 10.—Dorsal surface of head and anterior part of body. $\times 3$.



A. K. Mondal del.

Indian species of *Gagata* Bleeker

EXPLANATION OF PLATE II.

Indian species of *Batasio* Blyth.

Batasio tengana (Hamilton).

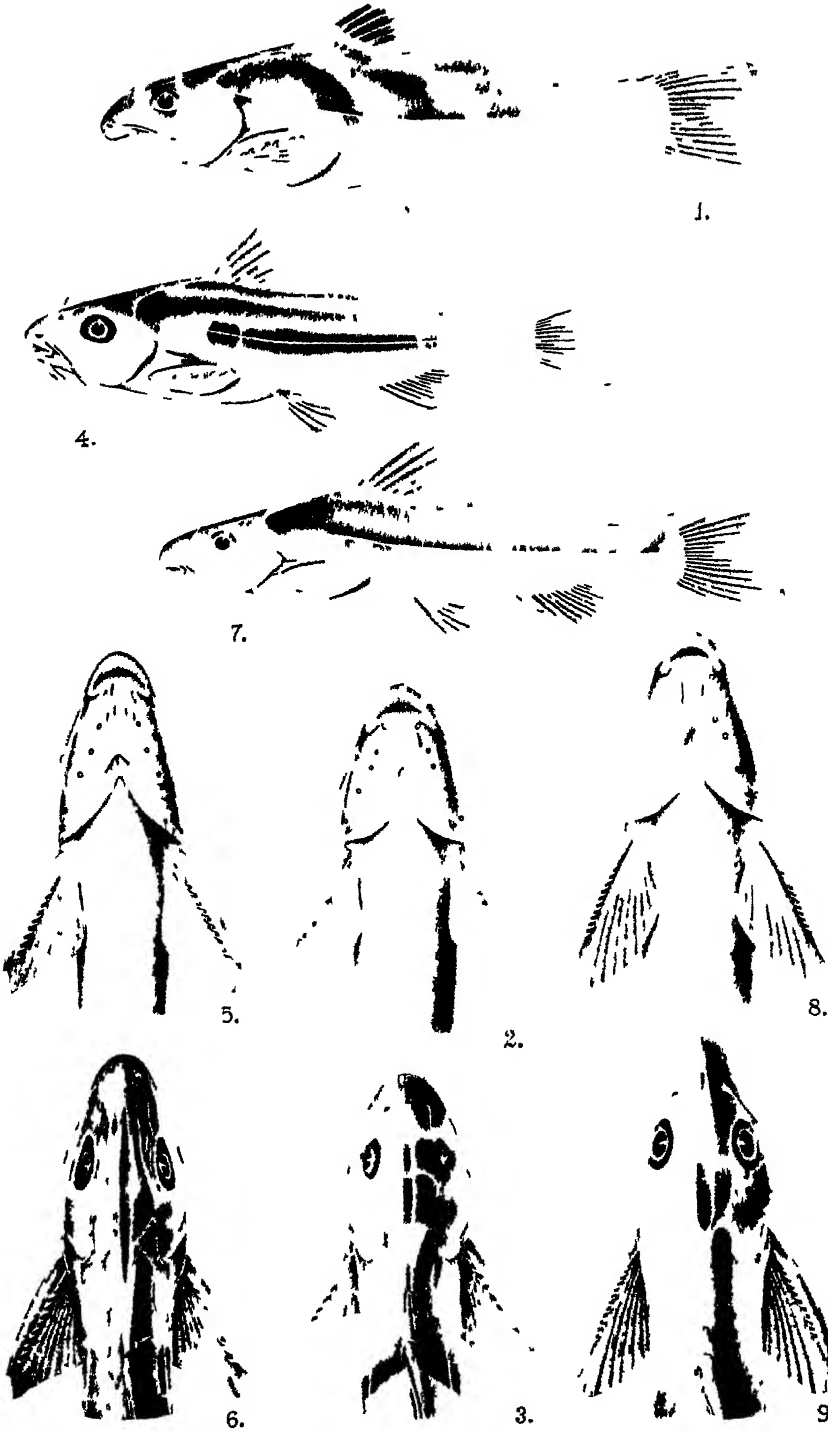
FIG. 1.—Lateral view of a specimen from Duars, Eastern Himalayas. $\times 1\frac{1}{3}$.
FIG. 2.—Ventral surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.
FIG. 3.—Dorsal surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.

Batasio batasio (Hamilton).

FIG. 4.—Lateral view of a specimen from Duars, Eastern Himalayas. $\times 1\frac{1}{3}$.
FIG. 5.—Ventral surface of head and anterior part of body of same. $\times 2$.
FIG. 6.—Dorsal surface of head and anterior part of body of same. $\times 2$.

Batasio travancoria, sp. nov.

FIG. 7.—Lateral view of type-specimen. *Nat. Size.*
FIG. 8.—Ventral surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.
FIG. 9.—Dorsal surface of head and anterior part of body of same. $\times 1\frac{2}{3}$.



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Indian species of *Batasio* Blyth.

OBSERVATIONS ON A NEW GREGARINE, *STYLOCEPHALUS BAHLI*, SP. NOV. FROM THE ALIMENTARY CANAL OF AN INDIAN BEETLE, *GONOCEPHALUM HELOPIOIDES* FRM.

By P. L. Misra, *M.Sc.*

(Zoological Research Laboratory, University of Lucknow.)

(Plate III.)

CONTENTS.

INTRODUCTION.

In October 1938, while examining the alimentary canal of the common beetle *Gonocephalum helopioides*, I found that it was heavily infested by a gregarine belonging to the genus *Stylocephalus*[1] which has so far not been recorded from India. A study of the structure and life-history of this gregarine presented several features in which it differs from other species recorded so far, and I have therefore instituted for

[1] As the name *Stylorhynchus* was pre-occupied, *Stylocephalus* has been substituted for it by Ellis (1912).

this gregarine a new species, which I have associated with the name of my Professor Dr. K. N. Bahl of the Lucknow University.

MATERIAL AND METHODS.

From October to March specimens of the beetle *Gonocephalum helopioides* were collected from the University grounds at Lucknow, but during May and June they were found only in moist places, *e g.*, under shrubs on the banks of the river Gumti. During the rains they become scarce but can be found in hollows of trees and in heaps of cattle dung.

After removing the elytra and clipping off the head and the posterior end of the abdomen, the entire gut was removed from the posterior end. The parasites are sometimes seen even without opening the gut, particularly in starved specimens. The gametocysts are also easily detected within the intestine and the rectum. For making smears the gut was teased in a drop of normal saline solution, the parasites taken out, dried in air for a couple of minutes and fixed in Schaudinn's fluid (half an hour), Carnoy's mixture (five to ten minutes), Sublimate-acetic (seven to twelve minutes) or Bouin's fluid (two to three hours). Ehrlich's haematoxylin, Delafield's haematoxylin and Mann's methyl-blue-eosin were used as stains for the smears. The gametocysts were fixed in the same fixatives and stained in Heidenhain's iron-alum haematoxylin. For sectioning, the gametocysts were fixed in Dobell's modification of Bouin's fluid (one hour on the paraffin bath and twenty-three hours at the room temperature), sectioned at 1-3 μ and stained with iron-alum haematoxylin. Liver tissue was tried as a support but it did not prove satisfactory. I therefore injected the cysts by means of a fine pipette into a piece of mid-gut. It is not essential to tie the cut-ends of the gut. At first, a certain quantity of the fixative was injected into the gut to avoid the action of the gastric juice upon the spores in those cases in which the cyst had automatically ruptured and the spores had come out, and then by a careful manipulation, the cysts or the chains of spores with the cystic wall could be lodged within the mid-gut, which was itself immersed into the fixative. To study the endogenous stages of development, the infected gut was fixed in Brasil's modification of Bouin-Duboscq fluid, Dobell's modification of Bouin, Sublimate-acetic (acetic acid four per cent.) and Gilson's mixture. Washing, dehydration and clearing were carried out in the usual way and paraffin was used as imbedding medium. Sections were cut 2-6 μ thick and were stained with Heidenhain's haemotoxylin or its modification by Dobell and counter-stained with eosin, Orange-G, Van Gieson's picro-säurefuchsin and Chromotrop 2 R. Giemsa's stain and Mallory's triple stain were also tried but they did not yield good results. Of all the preparations I find that those fixed in fixatives containing picric acid and stained with Heidenhain's haematoxylin and Chromotrop 2 R gave by far the best results.

"Culture" of the cysts :—The gametocysts could easily be collected from the faecal matter of the host (their detection being facilitated by using a piece of black paper or black porcelain background) by soaking the faeces in water and pipetting off the cysts. After washing thorough-

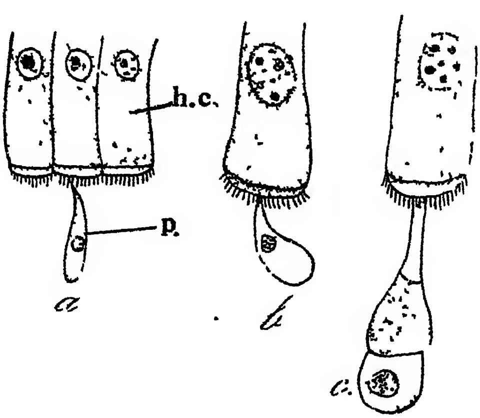
ly in distilled water, the cysts were kept in a drop of normal saline on a coverslip which was inverted upon a cavity slide and placed in a moist chamber. Observations upon cysts in these hanging drops were recorded every fourth hour and cysts at particular stages were fixed for further examination.

Other methods, for example, those adopted for studying the movement of the gregarine, the effect of certain acids and alkalis upon movement, the movement of microgametes, etc., are dealt with in their respective places in the text.

THE LIFE-HISTORY OF *STYLOCEPHALUS BAHLI*, SP. NOV.

(*a*) *Development of the young trophozoite.*

After its liberation inside the lumen of the gut of the host the sporozoite makes its way towards an epithelial cell, secures an attachment by penetrating its rostral end (text-fig. 1*a*) into the cell-wall and commences its development at the expense of the nutrient material of the parasitised cell. The cause of the diffluence of the parasitised cell-wall still remains undetermined although it is generally held that certain toxins produced by the sporozoite are responsible for it. Léger and Duboscq (1903) have described and figured intra-cellular development in *Stylorhynchus longicollis*, in which the sporozoite makes its way into the cell, grows inside it for a certain duration and then evaginates, after which it remains attached to the host-cell as a cephalont. In



TEXT-FIG. 1.—*a*. A sporozoite of *Stylocephalus bahli* attached to an epithelial cell of the host's gut: ×1500. *b*, *c*. Developmental stages of the trophozoites: ×1500.

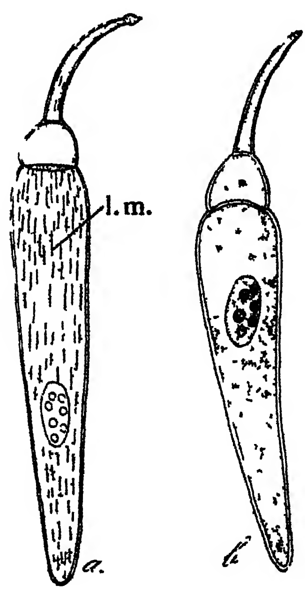
h.c., host-cell; *p.*, parasite.

Stylocephalus bahli, however, no intra-cellular stage could be seen. The parasite grows all the time extra-cellularly. The rostrum of the parasite within the cell-wall forms primarily an attaching organ. the

epimerite (text-fig. 1 *b*, *c*). Later, this function of attachment is, in all probability, superseded by its capacity to absorb the nutrient material out of the host-cell because as growth proceeds the parasitised cell becomes completely disfigured. The youngest trophozoite I could come across measured 15 μ in length and showed faint indications of compartments (Pl. III, fig. 1). As growth proceeds, the compartments become well-defined into epi- proto- and deuto-merites. In younger stages the protomerite is longer than the deutomerite and possesses a comparatively denser cytoplasm. Later, however, the deutomerite becomes enormously dilated and further growth leads to its prolongation, whereby it remains widest immediately behind the septum and tapers gradually towards its posterior extremity. At this stage the host-cell becomes degenerate having its nucleus more or less crumpled and its cytoplasm less dense than that of a normal cell.

(*b*) *The structure of an adult trophozoite.*

The body of a full-grown trophozoite (text-fig. 2 *a*, *b*) is elongated and is divided by septa into epi- proto- and deuto-merites. The epimerite is a hollow, tube-like structure, consisting of two parts: (1) a

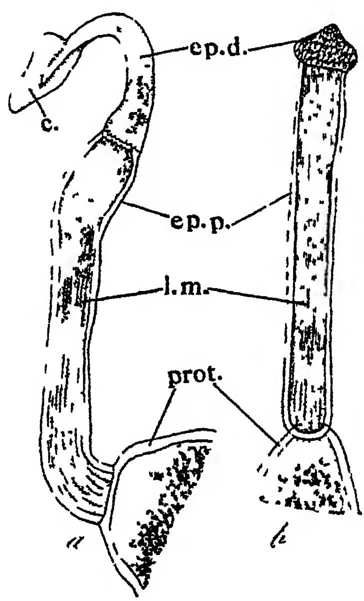


TEXT-FIG. 2.—*a.* An adult cephalont of *S. bahli* examined *in vivo*: ×150. *b.* A cephalont fixed in alcoholic Bouin and stained with Heidenhain's haematoxylin: ×168.

l.m., longitudinal myonemic striations.

proximal and (2) a distal, agreeing in this respect with the epimerite of *S. gladiator* (Blanchard) Watson, but differing from all the other

species of this genus. The distal part is a tongue-like process which remains in intimate contact with the host-cell (text-fig. 3 *a*); when torn apart from its moorings. a crown-like fringe—the torn parts of the host-cell—comes off along with it and obscures the details of its structure. Only rarely could an epimerite be secured, in which its distal end did not carry the remains of the parasitised cell, and in such a case a minute ring could be identified at its extreme distal end. In certain cases well-defined protruberances could be noticed at the end of the epimerite when it was in a contracted condition (text-fig. 3 *b*). The proximal part is retractile and hyaline in appearance. Several longitudinal fibrillae (text-fig. 3 *a*, *b*; *l.m.*) are seen running along the whole length of the proximal portion of the epimerite to which they impart its power of retractility.



TEXT-FIG. 3.—*a*. Portion of a freshly detached cephalont of *S. bahli*: ×850. *b*. Showing contracted distal portion of the epimerite: ×850.

c., torn off portion of the parasitised cell; *ep. d.*, distal portion of the epimerite; *ep. p.*, proximal portion of the epimerite., *l.m.*, longitudinal myonemes; *prot.*, a portion of the protomerite.

The protomerite of an adult trophozoite is typically broader than long and is conical or sub-conical in shape. Thus it differs from that of the other species of *Stylocephalus*. It is separated from the deutomerite by a fairly thick septum forming a distinct constriction. The cytoplasm has the same characters as those of the deutomerite (*vide infra*) except that it is less dense and does not contain big granules. Sometimes patches of chromatin material are present in its substance. The following tables give the measurements showing the ratio of the length of the protomerite to the total length and also the ratio of its width to that of the deutomerite.

TABLE 1.—*Showing the ratio of the length of the protomerite to the total length of the body.*

Length of the protomerite (L. P.) in microns.	Total length of the body (L. T.) in microns.	Ratio of the length of the protomerite to the total length (L. P. : L. T.).
20	160	1 : 8
20	900	1 : 45
30	162	1 : 5·4
40	1,010	1 : 25·2
48	1,008	1 : 21
50	1,045	1 : 20·9
58	1,054	1 : 18·1
66	896	1 : 13·5
75	1,100	1 : 14·6
75	1,100	1 : 14·6

Average L. P. : L. T. :: 1 : 18·63

TABLE 2.—*Showing the measurements and ratios of the width of the protomerite to the width of the deutomerite.*

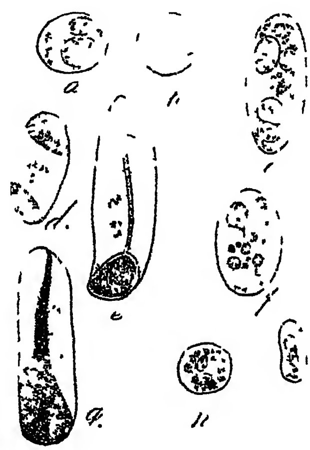
Width of the protomerite (W. P.) in microns.	Width of the deutomerite (W. D.) in microns.	Ratio of the width of the protomerite to the width of the deutomerite. (W. P. : W. D.)
20	30	1 : 1·5
60	76	1 : 1·2
66	91	1 : 1·3
66	91	1 : 1·3
72	120	1 : 1·6
72	120	1 : 1·6
83	94	1 : 1·1
83	132	1 : 1·5
83	132	1 : 1·5
33	40	1 : 1·2

Average W. P. : W. D. :: 1 : 1·38.

The deutomerite is the largest segment of the body and is circular in cross-section. It is broadest immediately behind the septum and

gradually tapers towards the posterior end but is never sharply pointed. The pellicle is 2·5 μ in thickness. Epicytial longitudinal striations are very clearly discernible in the living condition (text-fig. 2 *a*). The cytoplasm of the deutomerite consists of a semi-fluid matrix, charged with numerous granules of a brownish colour, some of which are fairly large in size. In between these granules there are often certain other granules which are smaller in size and appear pinkish in colour by reflected light. Usually with strong fixatives the general appearance of the cytoplasm appears entirely different from that in the living condition.

In the living condition the nucleus in the deutomerite appears as a translucent area situated anywhere between the septum and the posterior end of the body. Actually it moves from one place to another following the streaming movement of the protoplasm, but its speed is much slower than that of the cytoplasmic current. Further, it may not make a complete circuit but may make a short cut and come back



Text-fig. 4.—*a-i*. Nuclei of *S. bahli* showing various types of accumulations of the chromatin material: ×850.

to the position from which it started. How its movement is controlled is not clear. Ray and Chakravarty (1933) have mentioned a "system of tethering threads" attached to the concave surface of the half-moon-shaped nucleus of *Monoductus lunatus* and maintain that the contractions and relaxations of these threads are responsible for determining its shape and position in the deutomerite. No such arrangement for adjusting its location could be detected in the nucleus of *Stylocephalus bahli*, and the change of its position, presumably, appears to be passive.

The nucleus is very variable in size, shape and structure. In a young cephalont it is spherical, subspherical or ellipsoidal in shape and its size is comparatively bigger in relation to the body as compared with that of the adult forms. A normal full-grown nucleus is always ellipsoidal and measures on an average 57·5 μ×35 μ. It has a distinct nuclear membrane surrounding the nucleoplasm in which several karyosomes are clearly discernible in the living condition (text-fig. 4 *c*, *f*, *h*). Their number varies from two to ten. The nuclear

membrane takes a deep stain with iron-haematoxylin and appears to be chromatinic in character. In certain cases its boundary was seen to be irregular and shrunken, but this seems to be due to the effect of fixation. The nucleoplasm does not appear uniform in character, certain portions being denser and more granular and exhibiting a stronger affinity for chromatin stains than the others. Sometimes, however, probably prior to nuclear division, the karyosomes were seen to be absorbed and the chromatin masses accumulated at the two ends of the nucleus (text-fig. 4 *d*). These two darkly stained areas might get connected by a thin strand which also stained deeply with chromatin dyes (text-fig. 4 *e*). Further, the accumulation of the chromatin mass might be on one side only, presenting thereby a "geflammtc" appearance inside the nucleus (text-fig. 4 *g*), or there might be an intermediate condition between these two extremes, *i.e.*, at one end the accumulation would be very dense and at the other very faint. The significance of these variations in the arrangement of the chromatinic substance in the nucleus is not clear.

(*c*) *The sporonts.*

The sporonts can be distinguished from the cephalonts by the absence of the epimerite and by their being charged with greater quantity of reserve granules, which lend the cytoplasm a dark-blue appearance. Further, the sporonts are more inert than the cephalonts as regards locomotion. The sporonts of *S. bahli* are characteristically solitary and measure 200-2000 μ in length. The ratio of the length of the protomerite to the total length in an individual of maximum size is 1 : 37·5. The protomerite is broader than long and the ellipsoidal nucleus lies in the elongated deutomerite, which in its general outline is of the same shape as that of the adult trophozoite. After moving solitarily for some time the sporonts generally unite in pairs and encyst.

As regards the detachment of the epimerite from the protomerite at the time of the formation of the sporont, previous workers have expressed different opinions. For example, Duke (1910) says, "Just at the line of junction between the protomerite and epimerite a bubble-like vacuole appears, which gradually increases in size............ Having reached a diameter about equal to that of the protomerite the vacuole bursts, and the gregarine is suddenly deprived of its epimerite". Further she says, "This vacuole-formation.......... in my opinion has a probable bearing on the mooted question regarding the fate of the gregarine epimerite, in the transition from cephalont to sporont." Thus she means that vacuole-formation causes detachment of the epimerite. On the contrary, my observations on *Stylocephalus bahli* prove that the formation of a bubble at the hind end of the detached epimerite and the front end of the protomerite is an after-effect of detachment rather than its cause, and is due to the interaction between two dissimilar media, the saline solution and the cytoplasm. Personally, I believe that it is normally the ageing and its effect on metabolic activities which are responsible for the separation of the epimerite. Léger and Duboscq (1902) have also recorded vacuole-formation in *Pyxinia mo-*

buszi. Frenzel[1] in his observations on several cephalonts, came across some individuals with only a small projection which represents the epimerite on the protomerite; he concludes that the epimerite slowly degenerates and is absorbed in the same way as a tadpole's tail is absorbed during metamorphosis. A sudden disappearance of the epimerite, according to him, is pathological. Lühe (1904) is of opinion that the falling off of the epimerite is a typical method of cephalonts becoming free. My observations on *S. bahli* coincide with those of Frenzel as I have seen extruded and the so-called absorbed epimerites in the same smear. The variable lengths in the epimerites of *S. bahli* at least are not due to their varying degrees of absorption, but to their degree of retractility. It was noted that when teased the epimerites, either by contact with needles or by the strain imposed upon them by setting apart from their host-cells, retracted partially or wholly, and it is this power of retractility which is responsible for the variations in the lengths of the epimerites.

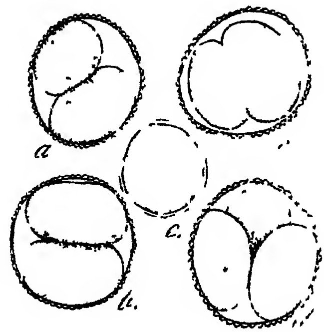
(*d*) *Association.*

(i) *Normal association.*—Two mature sporonts first associate by their anterior ends (text-fig. 5) forming a pair which keeps moving

TEXT-FIG. 5.—Sporonts of *S. bahli* in association: × 190.

[1] As quoted by Duke, H. L., *Quart. Journ. Micros. Sci.* LV, p. 268 (1910).

for some time and then the two begin to approach closer and closer by their posterior ends and ultimately round off in a common cyst secreted from their outer surfaces (text-fig. 6 *a*, *b*, *c*). While rounding a process of concentration of cytoplasm takes place as is evinced by the diameter of the cyst which becomes much less than the length of the associates. In due course, elevations arise on the cystic wall forming numerous pointed, chitinoid protuberances. An examination of



TEXT-FIG. 6.—Gametocysts of *S. bahli* seen in fresh faecal matter: ×90.

a-c. represent normal association; *d.*, a triple association; *e.*, single individual encysted and devoid of chitinoid protuberances on the cystic wall.

freshly formed cysts revealed that the contained gametocytes are either of the same or of unequal size (text-fig. 6 *a*, *b*). This inequality of size indicates sexual differentiation of the sporonts. Still more cogent and convincing proof of sex-differentiation, however, becomes available on an examination of permanent preparations of these cysts in which nuclear division has taken place (Pl. III, fig. 7). The nucleus of the male gametocyte divides earlier and with greater rapidity than that of the female. Thus, dissimilarity begins at this stage and leads to an undoubted case of anisogamy, in which the male contains only the motile microgametes and the female non-motile macrogametes.

As regards unequal gametocytes encysting together in a common cyst, Woodcock (1906) says, "Probably, in any case, the associates require to be of about equal age and size if the union is to be successful." Berndt (1902) says that no true cyst-wall is formed in those cases of syzygy in which the members are of considerable difference, and ultimately they die off. Siedlecki, Léger and Brasil have quoted examples where the sporoblasts have been produced by one member of the couple in the usual manner, the other remaining stationary and ultimately dying off. Further, Woodcock (1906) says: "One gregarine of a couple can in certain cases, apparently, exert sufficient influence upon its associate to induce it to commence sporulation, although it itself may not be ripe enough to do so and as a result not only does it not benefit by the stimulus or "Reiz" of the other, but, this on the contrary, appears to harm it and it succumbs instead." My observations on *S. bahli* do not absolutely conform with the views and observations of the authors mentioned above. No doubt cysts containing unequal associates can be seen to disintegrate at times, but the dis-

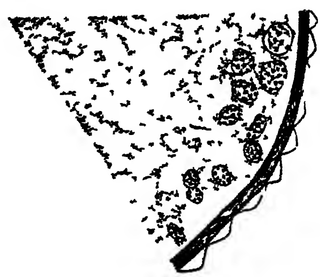
integration is not confined to them only. Couples of equal sizes have also been seen by me to disintegrate, probably on account of certain inhibitory factors. The formation of gametes, their mutual fusion, zygote- and spore-formation was clearly noted even in those cases where one member of the couple was approximately half in diameter as compared with its partner. Nuclear division was, however, set up earlier in the smaller member and microgametes were formed out of its substance indicating that it was really the microgametocyte. The only difference that could be detected in cases of unequal association lay in the size of the residual cytoplasm of the gametocyst which in this case was smaller in comparison to that found in equal but fully matured associates. Usually, the normal gametocysts measure 208 μ—352 μ × 80 μ—320 μ and are spherical, sub-spherical, or egg-shaped in appearance (text-fig. 6 *a*, *b*, *c*).

(ii) *Abnormal association and encystment.*—Not infrequently some gametocysts taken from the faecal matter within the rectum or outside were found to possess three individuals encysted together (text-fig. 6 *d*). Such abnormal cysts have already been recorded by Kunstler (1892) in *Diplocystis schneideri*, Cuénot (1901) in *Diplocystis* sp., Berndt (1902) in *Gregarina cuneata*, Woodcock (1906) in *Cystobia irregularis*, Cunningham (1907) and Robinson (1910) in *Kalpidorhynchus arenicolae*, Bastin (1919) in *Monocystis agilis*, Mary Vincent (1922) in *Pyxinia anobii*, Bhatia and Setna (1926) in *Monocystis matthai*, and Setna and Bhatia (1934) in *Hirmocystis parapencopsisi*. Cuénot has recorded instances of triple association, which are very rare, in *Diplocystis*, one of which had apparently produced sporoblasts; but Woodcock (1906) remarks, "Judging from his (Cuénot's) fig. 47, however, sporulation would not seem to have been successful, the sporoblasts being extremely minute and scarcely visible, very different from the well-developed layer in the normal cysts figured". Bastin has seen similar abnormal cysts of *Monocystis agilis*, and was able to notice the formation of gametes. Bhatia and Setna have detected fully-developed spores in a case of triple association in *Monocystis matthai* and thus have supported Cuénot's and Bastin's observations. On no occasion could I observe in the triple association of *S. bahli* either complete gamete-formation or any other advanced stage of sporulation. Only twice nuclear divisions were seen to have taken place partially in two out of the three associates, but in all cases they ultimately degenerated.

Encystment of a single individual has also been encountered at times by watching mature sporonts in saline on a slide. After moving for some time the sporont becomes less vigorous, contracts gradually, till it becomes globular and then secretes a wall round itself (text-fig. 6 *e*). The whole process takes from one-and-a-half to four hours when kept in normal saline solution. No protuberances could be seen on the wall of such an encysted individual. Such individuals ultimately perish and in this respect my observations confirm those of Brasil (1905) who recorded a similar fate for solitary encystment in *Gonospora* and *Urospora*. Siedlecki, Cuénot, Berndt, Léger and Cunningham, on the other hand, have asserted that they never encountered cases of solitary encystment.

(*e*) *Gamete-formation and anisogamy.*

After encystment the nucleus of each gametocyte soon prepares to divide. The nuclear membrane disappears and the chromatin mass becomes comparatively dense. The actual chromosome cycle could not be traced, but it was noticed that the nucleus of each gametocyte repeatedly divides into several daughter nuclei, which subsequently migrate to the periphery (text-fig. 7). This division, as already men-



TEXT-FIG. 7.—Portion of the section of the gametocyst of *S. bahli* showing nuclear migration to the periphery: $\times$ *ca* 1000.

tioned, begins and is completed earlier in the male gametocyte than in the female (Pl. III, fig. 7. *m.*, *f*). The cytoplasm of each gametocyte segments around each nucleus and thus the gametes are formed. The whole process of gamete-formation takes from eight to twenty hours from the time the freshly extruded cysts are kept in the moist chamber. This duration depends chiefly upon temperature, as I find that the period decreases with the rise of temperature, the optimum results having been obtained at 37°C.

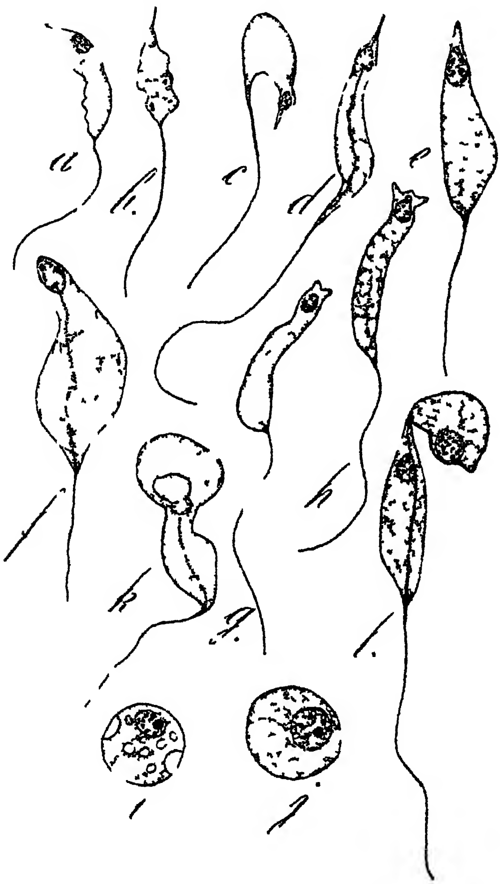
Anisogamy:—An examination of smears obtained by puncturing the mature gametocysts revealed that the gametes could be distinguished into: (i) the microgametes, and (ii) the macrogametes.

(i) The microgametes:—All the microgametes are not of the same kind. On a close examination three types can be distinguished, *viz.*,

(*a*) Normal, fusiform, but sterile microgametes.
(*b*) Normal, pyriform, fertile microgametes.
(*c*) Abnormal microgametes.

A fresh preparation, in a slightly albuminated physiological saline, of a ruptured gametocyst in which gametes have formed, shows that there are two kinds of actively moving microgametes: (i) The first kind of microgametes are fusiform in shape and are fewer in number than (ii) the second type, which are pyriform in shape, 14 to 21 μ in length and more abundant but less active than the first type. The fusiform microgametes have generally two or three prominences (text-fig. 8 *g*, *h*) on the head and are sterile (*vide infra*); while the pyriform microgametes (text-fig. 8 *a-e*) have only one anterior prolongation, the perforatorium on their heads, and are fertile and appear to possess an acute sensitivity for tracing out the receptive spot of the macrogamete (Pl. III, fig. 2, $\times$).

Fixed and stained preparations revealed the nucleus of the microgametes lying within the head, and containing three to five deeply staining bodies in a homogeneous and faintly staining nucleoplasm The cytoplasm is vacuolated and granular in character. An axial filament, easily seen to arise from the perforatorium (text-fig 8 *d*, *l*), traverses the whole length of the body and continues behind as a whip-like tail, which helps the microgamete in its movement.



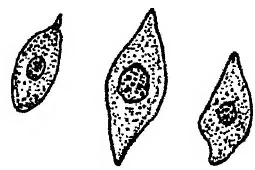
TEXT-FIG. 8.—*a-e.* Normal, pyriform microgametes of *S. bahli* : × 1333. *f.* An abnormal microgamete : × 1333. *g, h.* Fusiform, sterile microgametes : × 1333. *i.* A macrogamete : × 1750. *j.* An abnormal macrogamete : × 1750. *k.* Fusion of a microgamete with a macrogamete · × 1750. *l* A microgamete attached to a zygote : × 1375.

Further, abnormal microgametes (text-fig. 8 *f*) have also been encountered. These are distinguished by their bigger size, blunt anterior end and a fairly stout and stumpy posterior tail. They degenerated ultimately.

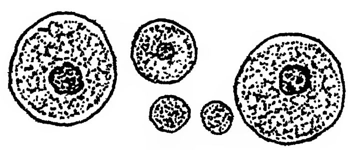
(ii) The macrogametes :—They are more or less spherical bodies, measuring 6 μ to 8 μ in diameter. The spherical nucleus is 2 μ in diameter with a well-marked nuclear membrane ; it possesses an eccentrically placed karyosome and four or five chromatoid bodies (text-fig.

8 *i*). The cytoplasm is very much vacuolated and is packed up with reserve granules. There are two thin, hyaline areas at the periphery forming receptive spots, which permit as well as facilitate the entrance of the microgametes. Sometimes, abnormal macrogametes (text-fig. 8 *j*), comparatively bigger than the normal ones, were also met with in some of the preparations.

Degenerating gametes:—Some preparations revealed small bodies which on closer examination proved to be degenerating gametes of varying sizes. Tail-less, spindle-shaped bodies with crumpled nuclei



a.



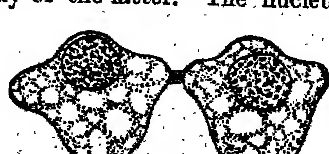
b.

TEXT-FIG. 9.—*a*. Degenerating microgametes: × *ca*. 2800. *b*. Degenerating macrogametes: × *ca*. 2800.

were apparently degenerating microgametes (text-fig. 9 *a*), while other bodies (text-fig. 9 *b*) in which the nucleus had shrunken and the cytoplasm contracted, with a consequent decrease in size were recognised as the degenerating macrogametes.

(*f*) *Fertilisation and spore-formation.*

Coupling of the gametes takes place after the dissolution of the partition between the male and the female chambers when the microgametes rush towards the macrogametes. All the microgametes however, do not go into the female chamber, but there is a displacement of the macrogametes from the female chamber into the male chamber, with the result that coupling can be observed simultaneously in both the compartments. The microgametes agitate violently to and fro, and as soon as they come in contact with suitable partners, mating takes place quickly. The fertile microgametes generally pierce through the receptive spots (Pl. III, fig. 2, ×) of the macrogametes, only one finding entrance into the body of the latter. The nucleus of the microgamete

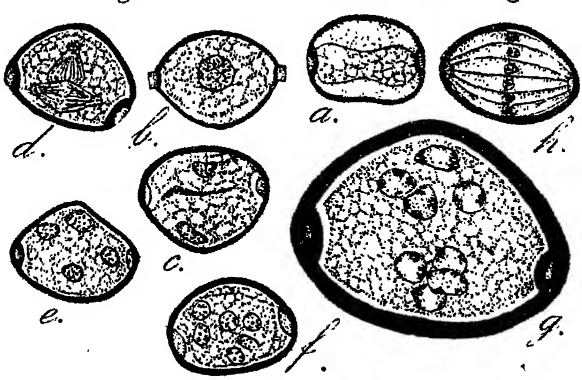


TEXT-FIG. 10.—Two zygotes of *S. bahli* attached with each other: ×4000.

approaches that of the macrogamete and fuses with it (text-fig. 8 *k*). It takes two to eight minutes for a microgamete to fuse completely with the body of the macrogamete. The act of fertilisation being thus accomplished, the fertilised macrogamete or the zygote slightly elongates (text-fig. 10), secretes a wall around it and becomes a spore (text-fig. 11 *a*, *b*). While examining a fresh preparation in which the microgametes were still moving within the cyst, it was found that the fertilised macrogametes became gradually arranged in chains; sometimes enchainment of even unfertilised macrogametes also takes place, in which case the microgametes could be seen making their way into the chains and fertilising the macrogametes there. Some microgametes were observed to remain active from six to fourteen hours after the complete enchainment of spores. These were, no doubt, mostly the sterile microgametes, which later on degenerate. The duration of complete sporulation was noted to be 48-60 hours.

(*g*) *Structure of the spores and formation of the sporozoites.*

The hat- or pouch-shaped spores (text-fig. 11 *a*, *b*) measure 11× 7·5 μ, and are arranged in chains which show a coiling tendency if de-



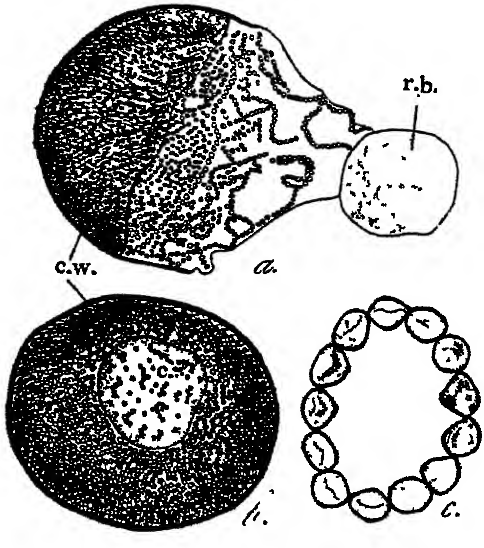
TEXT-FIG. 11.—*a*, *b*.—Spores: ×1727. *c-f*. Spores showing nuclear division: ×1727. *g*. A spore with eight nuclei: ×3454. *h*. A mature spore with sporozoites: ×1727.

tached away from the cyst. The cystic wall is 0·5 μ thick. It is brownish in colour and becomes almost black after the formation of sporozoites. The cytoplasm of the spore is alveolar in appearance and possesses a marked affinity for chromatin stains, indicating the presence of chromatoid granules in it. The nucleus of the spore soon divides mitotically into two (text-fig. 11 *c*), the plane of division being at right angles to the long axis of the spore. The two daughter nuclei again divide mitotically into two each, and thus a quadri-nucleate stage is reached (text-fig. 11 *d*, *e*). At this stage, any two of the four may divide first whereby a six-nucleate stage (text-fig. 11 *f*) can be made out, or all the four may divide simultaneously and form eight nuclei (text-fig. 11 *g*). The latter seems to be the general tendency. At this stage, the chromatin of the daughter nuclei remains concentrated in patches at the periphery and the rest of the nucleoplasm stains faintly. The cytoplasm of each spore segments around the nuclei in such a way that the

segmented bodies, *i.e.*, the sporozoites lie parallel to each other along their long axes and also parallel to the long axis of the spore (text-fig. 11 *h*). Moreover, when viewed laterally, the nuclei of the sporozoites are arranged in a line, at right angles to the length of the sporozoites. Typically the sporozoite is spindle-shaped and measures 10 μ in length and 2 μ in width at its widest central region. Its cytoplasm is homogeneous, while the centrally situated nucleus is more or less spherical and possesses four or five deeply staining granules.

(*h*) *Dehiscence.*

After spore-formation, the residual cytoplasm acquires a wall around it forming a pseudocyst which under favourable conditions of warmth and moisture, swells up and causes the rupture of the cyst. The residual cytoplasm, thus, seems to be hygroscopic in nature. The rupture of the cyst is at times so violent as to liberate not only the spores but



TEXT FIG. 12.—*a*. A ruptured cyst showing the chains of spores: ×46. *b*. A gametocyst in which a lid-like portion has cleft apart leaving an outlet for the spores: ×188. *c*. A chain of spores magnified: ×500.

c., cavity; *c. w.*, cystic wall; *r. b.*, residual body.

also to throw out the cystic residue (text-fig. 12 *a*). On certain occasions, however, it was found that a well-defined lid was thrown off and the spores came out of it (text-fig. 12 *b*). At other times, it was observed that the cystic residue disintegrated and the dehiscence of spores, in such cases, was caused by a simple rupture, presumably caused by the pressure of the fluid formed by the dissolution of the cystic residue.

(*i*) *Probable mode of infestation.*

Infestation is purely accidental and involves only a single host to complete the life-cycle. When the host, *Gonocephalum helopioides* takes in food contaminated with infective spores, the sporozoites are liberated into the gut by the action of the gastric juices upon the spores and make their way towards the epithelial cells of the alimentary canal, where they commence their further development.

SEASONAL INTENSITY AND SITE OF INFESTATION.

The host-gut was found heavily infested during winter. The seat of infestation is usually the mid-gut and the intestine, but in cases of heavy infestation the parasites could be found right from the oesophagus to the rectum and in such cases the lumen of the posterior part of the intestine was entirely occluded by them (Pl. III, fig. 8). From March to June, gametocyst-formation is at its best and this process seems to be correlated with the rise of temperature; its optimum effect being during April, May and June. During July and August sporonts are often met with though not in abundance. An increase in the degree of infestation was noted during the latter part of September and reached its climax in October and November. On an average, 97 per cent. of the beetles were infected.

POLYNUCLEARISM.

There is a great divergence of opinion with regard to the occurrence of the phenomenon of polynuclearism in gregarines. Berndt (1902) has recorded the presence of certain patches, which stain darkly with chromatin dyes, specially in the protomerite. Comes (1907) noted similar patches in *Stenophora* and regarded them as metabolic products, not nuclear in origin. Schellack (1907) has reported the occurrence of darkly-staining areas in the epimerite of *Echinomera hispida*, while Duke (1910) detected such patches throughout the body of *Metamera schubergi*. In *S. bahli* one or two patches, having a strong affinity for chromatin stains, were noted in the protomerite as well as in the deutomerite (Pl. III, figs. 4, 5). However, the occurrence of the so-called several nuclei in the body of the gregarines should be regarded as abnormal. As regards their origin it is difficult to make a suggestion, but it is possible that an increase in the nuclear material causes a disturbance in the kern-plasma relation, whereby nuclear extrusion takes place and the diffused chromatin particles flow along with the cytoplasm and ultimately aggregate into definite patches in a particular part or parts of the organism.

HYPERPARASITISM.

A noteworthy phenomenon of hyperparasitism in *S. bahli* deserves special mention. Under pathological conditions this gregarine appears

to be susceptible to certain infections which may be classed as (*a*) cytoplasmic, and (*b*) nuclear.

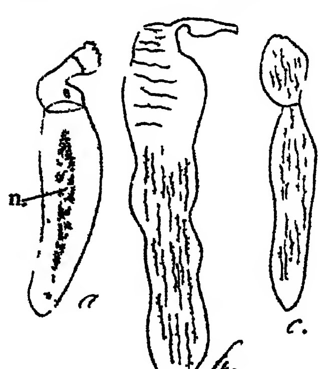
(*a*) *Cytoplasmic parasitism.*—A longitudinal or oblique section (Pl III, fig. 6 ; text-fig. 13 *a*) of an infected gregarine after staining with Heidenhain's haematoxylin showed the whole of the cytoplasmic area in the deutomerite having been parasitised by numerous multinucleate amoeboid bodies (text-fig. 13 *b*)—probably *Metchnikovella.* These could not be diagnosed as no spores were met with. Their exact systematic position needs further investigation.

(*b*) *Nuclear parasitism.*—In certain cases nuclei could be observed to have been infected with a fungus, probably belonging to the family

TEXT-FIG. 13.—*a*. An oblique section of the parasite showing multinucleate amoeboid bodies in its cytoplasm : ×*ca*. 950. *b*. Two multinucleate amoeboid bodies magnified : ×*ca*. 2300. *c*. Two parasitised nuclei : ×600.

a. b., amoeboid bodies.

Chytridiaceae (text-fig. 13 *c*). The infection seems to begin at the centre of the nucleus, and to proceed to the periphery, thereby causing a dis-



TEXT-FIG. 14.—*a*. A cephalont of *S. bahli* showing degenerating parasitised nucleus (*n.*) : ×90. *b, c*. Degenerating individuals in which the nucleus has vanished : ×65.

solution of the nuclear membrane (Pl. III, fig. 3). The infected nucleus gradually degenerates, and the gregarine loses its metabolic activities, till at last it perishes (text-fig. 14 *a-c*).

EFFECT OF THE PARASITE UPON THE HOST.

Inspite of the fact that the host is heavily infested, it does not seem to suffer any serious damage. Only the parasitised epithelial cells of the gut-wall undergo some change and appear abnormal on account of a deficiency in their cytoplasmic contents, and sometimes owing to the atrophy of their nuclei. In some cases, where occlusion occurs, the parasites must be inhibiting the passage of food-material from the anterior to the posterior end of the gut of the beetles. But, nevertheless, the host does not succumb, as it is hardy enough to withstand starvation for a long period during which the parasites encyst and pass down to the rectum leaving the passage clear once more for food.

SYSTEMATIC POSITION.

The solitary nature of the sporonts, dehiscence by pseudocyst, spores hat-shaped, brown or black in colour and disposed in chains are characters which assign this gregarine to the family Stylocephalidae Ellis. The epimerite with a dialated papilla at the end of a long slender neck, cysts beset with small papillae and hat-shaped spores determine its assignment to the genus *Stylocephalus*. The species *S. bahli* differs from the hitherto described species of *Stylocephalus* in possessing the following features :—The epimerite is peculiar and consists of two parts: (i) a distal tongue-like portion and (ii) a proximal tubular portion which is hyaline and retractile. In this respect it partially resembles *S. gladiator* (Blanchard) Watson, but differs from the latter in having the apical portion of the epimerite not longer than the rest of the body in the adult condition, and also in possessing a fairly large size; the maximum size of *S. gladiator* being 720 $\mu \times 70$ μ, while that of *S. bahli* is 2000 $\mu \times 98{\cdot}7$ μ. The protomerite of *S. bahli* is broader than long and is conical or sub-conical in shape, hence it differs from others in this respect. Further the nucleus of *S. gladiator* is ovoidal and contains a single karyosome, whereas the nucleus of *S. bahli* is ellipsoidal and contains several karyosomes. Thus it resembles, in this respect, *S. oblongatus* and *S. longicollis*, but differs from them in other respects, *e.g.*, in the shape of the protomerite, the shape of the cyst, the size of the spores, etc.

The following table (on pp. 62 and 63) shows the various points of resemblance and difference between *S. bahli* and other species of this genus which have been previously described.

To sum up, the specific characters of *S. bahli* are as follows :—Sporonts solitary, elongate, maximum size 2000 $\mu \times 98{\cdot}7$ μ; L. P. : L. T. : : 1 : 37·5 in maximum-sized individual; epimerite elongated, hollow and tubular consisting of a retractile proximal and a tongue-like distal portion; protomerite conical or sub-conical; L. P. : L. T. : : 1 : 18·63; W. P. : W. D. : : 1 : 1·38; deutomerite broadest behind the septum and gradually tapering posteriorly; pellicle 2·5 μ thick; endocyte brown in cephalonts, dark-bluish in sporonts; nucleus ellipsoidal with several karyosomes; cysts spherical, sub-spherical or egg-shaped; dehiscence by pseudocyst or simple rupture; spores hat-shaped, dark-brown or black, $11 \times 7{\cdot}5$ μ.

Characters.	*S. oblongatus.*	*S. longicollis.*	*S. brevirostris.*	*S. gladiator.*
1. Sporonts .	Solitary, elongate, maximum length 3000 μ.	Solitary, elongate, measurements not mentioned.	Solitary, stout bodied, maximum size not mentioned.	Solitary, elongate; maximum size 720 μ.
2. Epimerite .	A thick cylindrical neck with a terminal dilated portion with papilla on extremity; whole epimerite being one-and-a-half to twice the length of the protomerite alone.	A long slender cylindrical neck terminating in a slightly dilated papillate anterior end; the whole being three or four times the length of the protomerite alone.	A small xiphoid coinoidal tongue projecting upward from the centre of the protomerite, whole length being equal to half that of the protomerite.	Consists of two parts: (i) a very long slender neck and (ii) a dilated xiphoid-shaped apical portion, often longer than the whole body.
3. Protomerite .	Globular, constriction at septum.	Pentagonal in lateral optical view, truncate at apex; slight constriction at septum; width equal to length.	Cylindrical, of nearly equal width throughout, corners rounded at anterior end; no constriction at septum; width equal to length.	Short and globular.
4. Deutomerite .	Cylindrical, tapering slightly from middle, ending in a rather slender blunt posterior extremity.	Elongate, cylindrical, tapering in posterior two-thirds and ending in a rather blunt point.	Just below the septum it is a little wider than the protomerite and tapers to a rather sharp point.	Elongate, cylindrical, with a slender attenuated extremity, bluntly pointed.
5. L. P. : L. T.	1 : 6 to 1 : 8	1 : 10	1 : 4	×
6. W.P. : W.D.	1 : 2	1 : 1·1	1 : 1·2	×
7. Nucleus	Ellipsoidal with several karyosomes.	Ellipsoidal with several karyosomes.	Spherical with 6 to 9 small karyosomes.	Ovoidal with one karyosome.
8. Endocyte	Yellowish in cephalonts becoming black in sporonts.	Dense	Not described	Not described.
9. Cyst	Irregularly spherical, with slight depressions and protuberances.	Irregularly spherical, surface covered with indentations and papillae.	Unknown	Unknown.
10. Spores	Brown, united in chains; 7 μ in length.	Same as in *S. oblongatus.*	Ditto	Ditto.
11. Host	*Opatrum sabulosum* (L), & *Ascida grisea* (F).	*Blaps mortisaga* .	*Hydrophilus* sp., larva	*Helenophorus collaris* L.
12. Habitat	Intestine	Intestine	Intestine	Intestine.
13. Locality	Paris and Poitiers, France.	Paris	Germany	Grenoble, France.

Characters.	*S. gigenteus.*	*S. insignis.*	*S. eledonae.*	*S. bahli.*
1. Sporonts	Solitary, elongate; maximum size 1800 .μ	Solitary, very elongate; length 1000 μ.	Solitary, maximum length 300 μ.	Solitary, elongate; maximum length 2000 μ.
2. Epimerite	A long pointed cone, situated upon a conoidal projection of the protomerite.	A large flattened disc, depressed slightly in centre crenulate on periphery, longitudinally striated and carrying at base a circle of very many short upwardly directed digitiform processes.	Long and thick style with a small knob at its extremity.	An elongated, hollow, tubular structure, consisting of two parts (i) a proximal neck which is hyaline and retractile and (ii) a distal tongue-like portion. Length on an average two-and-a-half times than that of the protomerite but it never exceeds the total length of the adult gregarine.
3. Protomerite.	Dome-shaped, dilated above the base, and flattened anteriorly; constriction at the septum.	Sub-globose, flattened, twice as wide as high; constriction at the septum.	Hood-shaped or obtuse, cone-like in appearance; stuffed with small reserve granules; constriction at the septum.	Usually broader than long, conical or subconical; constriction at the septum.
4. Deutomerite	Cylindrical, widest at the septum, terminating in an abrupt but sharply pointed cone.	Cylindrical, widest at end of anterior third, flattened at posterior extremity.	Widest shortly behind the septum, tapering to a fully stumpy hinder end posteriorly.	Widest at the septum, tapering gracefully posteriorly, but never ending in a sharp point.
5. L.P. : L.T.	1 : 9 to 1 : 18	1 : 15	1 : 6 to 1 : 7	1 : 18 to 1 : 63.
6. W.P. : W.D.	1 : 1 to 1 : 1·5	1 : 1·3	1 : 1·2 to 1 : 1·4	1 : 1·38.
7. Nucleus	Not described	Spherical with one karyosome.	Relatively small	Ellipsoidal often with several karyosomes.
8. Endocyte	Dense	Not described	Conspicuously big granules present.	Brown in cephalonts becoming dark-blue in sporonts.
9. Cyst .	Spherical, diam. 450 μ; entire surface papillated; dehiscence by pseudocyst.	Sub-spherical or sub-ovoidal, diam. 430 × 330 μ; dehiscence by pseudocyst.	Unknown	Spherical, subspherical or egg-shaped; entire surface papillated; diam. 208 μ-352 μ × 80 μ × 320 μ; dehiscence by pseudocyst or simple rupture.
10. Spores	Irregularly sub-spherical, black and measure 11 μ × 7 μ united in chains.	Irregularly hat-shaped, 10 μ long, extruded in chains.	Unknown	Irregularly hat-shaped, dark-brown or black and measure 11 μ × 7·5, μ; united in chains.
11. Host .	*Eleodes* sp.; *Asida opaca* Say; *Ascida* sp., and *Eusattus* sp.	*Helops striatus*	(i) *Eledona agaricola*, Herbst. (ii) *Pentaphyllus testaceus*, Hellw. (iii) *Mycето-phagus piceus* Fabr.	*Gonocephalum helopioides* Frm.
12. Habitat	Intestine	Intestine	Intestine	Mid. gut and intestine.
13. Locality	Boulder and Denver, Colo.	Indre-et-Loire, France	(i) Fundort: By Sibyllenort. (ii) Fundort: Militsch. (iii) Fundort: Militsch.	Lucknow, U. P. India.

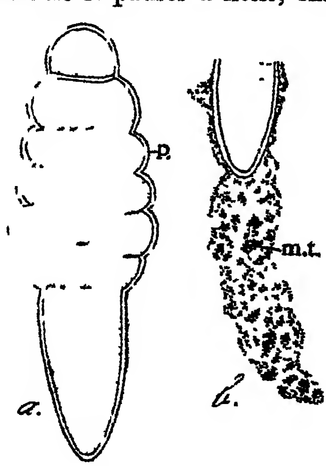
MOVEMENT.

(a) *Observations on the movement of* S. bahli, *sp. nov.*

When a piece of infected gut is teased on a slide and the gregarine examined under the microscope it does not move at all in the gut-fluid of the host. In distilled water slow movement can be observed, but only for a short duration. Normal saline is a suitable medium for studying the movements of gregarines, as they can live in it for a longer duration, and for this particular gregarine 0·9 per cent. saline solution proved a better fluid than the usual physiological saline solution.

The epimerite of *S. bahli* is retractile and shows active bending movements, as well as slight longitudinal contortions. When not retracted it moves to and fro and then curls up to form a coil which opens out with a jerk. More often complete bending is not effected and the epimerite moves to the right and and then to the left, as if it is searching for something. The protomerite also moves to and fro but with a greater activity than the epimerite. Sometimes it was noted that it could withdraw partially into the deutomerite and then suddenly sprang out to withdraw again, and this process was repeated several times. These movements can be compared with those of the neck of a turtle which is being partially withdrawn and extruded alternately. Occasionally, the septum was pushed into the protomerite by the onward flow of the cytoplasm of the deutomerite. These movements are, however, not necessarily seen at all times.

Sometimes, neither the epimerite nor the protomerite shows any active movements and the gregarine as a whole glides along passively. Usually *S. bahli* moves forward both by movements of epi-and protomerites and by gliding movements at the same time. When it comes in contact with an obstacle it pauses a little, changes its direction and



TEXT-FIG. 15.—*a*. A specimen of *S. bahli* showing cap-like protuberances (*p.*) : × *ca.* 200. *b.* An individual showing the mucus-tail (*m.t.*) : × 200.

continues forward. In its attempt to put aside obstacles in its way several cap-like projections, (2-12), are formed on the deutomerite

(text-fig. 15 *a*), these protuberances are produced as a result of the pressing of the body against the obstacle lying in front, and when the organism is unable to push that obstacle away, it recoils with a backward jerk or takes a slight turn and makes its way onwards. Probably, it is this backward jerk which certain authors have mistaken for a backward movement. I have never been able to detect in this gregarine a backward movement similar to its forward movements. I have also noted that an individual at times, while gliding, forms a slight curve on its body and then instantaneously straightens out, in which act the body, instead of moving forwards moves at right angles to its long axis; it is this lateral flexion, probably, which Crawley has named "transverse" movement[1].

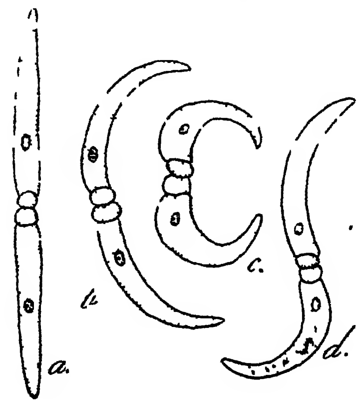
In order to test whether this gregarine could move only when in contact with a surface, half a dozen specimens were kept in saline solution under a wax-legged cover-glass and examined under high power. By changing the focus of the microscope it could be seen that they remained attached to the slide on which they moved. I was unable to see any of the gregarines leaving the slide to move upwards and reach the coverslip, as has been recorded by Crawley (*vide infra*).

Besides these facts, one important observation needs mention here. A fresh preparation in saline after five minutes showed a sticky and elastic tail being formed, presumably by the exudation of a mucoid substance from the body of the gregarine and its subsequent accumulation at the posterior end forming a "tail". To obtain a clear conception of this phenomenon about half a dozen gregarines were washed several times in saline solution, to get rid of the gut-fluid of the host and were kept in saline mixed with carmine suspension. It was observed that as the gregarines moved forward the carmine particles collected at their posterior ends and formed a "tail" (Pl. III, fig. 3, *m. t.*; text-fig. 15 *b, m. t.*). The "tail" may not be continuous. This suggests that there is a variation in the quantity of the exudate. It may be mentioned here that the "tail" actually retards the progress of the animal and when it becomes fairly big the organism, inspite of its best efforts to escape from it, succumbs at last. A definite trail or tract is often left behind each individual as it passes onwards.

In biassociative forms in which syzygy takes place by the union of the anterior end of the satellite with the posterior end of the primite, "tail-formation" is clearly visible at the hind end of the satellite, but a change in the direction during progression is steered by the primite; the satellite either helps the primite by moving in the same direction or just follows passively. In case the "tail" grows enormously big, cap-formation occurs in the bodies of the pair or the association snaps, in which case the primite escapes, leaving the satellite doomed to death. When the contact of the two associates takes place by their anterior ends only, forward progression comes to an end sooner or later and a rotatory movement is set up by the two individuals exerting forces in opposite directions. Their posterior ends approach closer and closer

[1] Personally, I consider that additions of such names should be avoided. For instance, "transverse" movements would be inconvenient on the part of an organism having the antero-posterior axis of its body longer than its transverse axis.

(text-fig. 16 *a*, *b*, *c*), and ultimately the pair rounds itself and becomes encysted in a common cyst. The rotatory movements may lead the



TEXT-FIG. 16.—*a*. Two sporonts of *S. bahli* in association; *b*, *c*., same deflected due to opposite forces during progression; *d*., showing an S-shaped deflection due to opposite forces not acting on the same side: × 55.

two individuals in opposite directions, whereby an S-shaped figure (text-fig. 16 *d*) is formed. In such cases it was noticed that after sometime their contact gave way and the organisms became free.

Albuminated saline or diluted glycerine inhibits progression with great rapidity. The action of certain acids, *e.g.*, 0·5 per cent. hydrochloric acid, nitric acid, sulphuric acid and acetic acid, as well as of certain alkalis, *e.g.*, 0·5 per cent. potassium hydroxide, sodium hydroxide, sodium carbonate, etc., proved in every case to be detrimental to progression, and caused death.

(*b*) *Discussion*.

The gregarines can move in a medium different from that of their natural environment, but the various factors bringing about their locomotion have formed a bone of contention amongst workers since the time the gregarines came to be known. Kölliker (1848) was the first to record the gliding and bending movements in gregarines, but he did not offer any explanation as to the cause of these movements. Leidy (1853) discovered the longitudinal striations of the epicyte and suggested their muscular function. Van Beneden detected the net work of transverse fibrillae—the so-called myocytes as named by Schneider (1873)—which are contractile and have been held responsible for the bending movements. Lankester (1872) reported upon the active movements of *Monocystis sipunculi* caused by the undulations of their lateral margins and suggested that they were like those of a planarian. Frenzel (1892) suggested that progression was due to a chemotactic affinity between the gregarines and their food, but this suggestion seems to be inadequate, as the gregarines do not show any movement on a slide with food materials on it. Following Lauterborn's observations on diatoms which move by the extrusion of gelatinous threads, Schewiakoff (1894) from his studies on *Clepsidrina muneri*, concluded that the same

phenomenon occurred in gregarines. According to him gelatinous threads exude through minute pores lying in between the ridges of the gregarines and accumulate at the posterior end. where they harden into a tough stalk, new additions to which push the animals forwards. Mühl (1921) demonstrated the presence of minute pores on the body by means of carbon tetrachloride. Lang and Doflein supported Schewiakoff's theory. while Calkins (1910) stated, "although very improbable at first sight, it is the only one thus far that fits the case". Schaudinn (1900) also supported Schewiakoff's observations by demonstrating the secretion of a gelatinous substance from the sporozoite of *Coccidium schubergi*. Although Schewiakoff worked out elaborately the mechanism of locomotion in gregarines for the first time. his emphasis upon the "mucus-tail" as a pushing element has led to a good deal of criticism. Crawley (1902, 1905) from his observations on *Stenophora juli* and *Echinomera hispida* concluded that myonemic contractions were entirely responsible for bringing about locomotion. and as mucus was merely dragged passively at the posterior end, tail-formation is an effect rather than a cause of locomotion. He says "It is an intrinsic weakness of Schewiakoff's explanation that it gives no reason why the gelatinous substance should pass backwards, instead of forwards or radially". In support of his view he has asserted that throughout the whole group of Sporozoa movement is exhibited only by those organisms which possess a muscular system. For instance, a gregarine even in its intra-cellular stage would exhibit movement, if detached from its moorings, but an adult coccidium is unable to move, as it possesses no muscular system. Further, movement is exhibited by Haemosporidia and Myxosporidia on account of the presence of a muscular system. whereas Amoebosporidia (Schizogregarines) are devoid of muscles. and are, therefore, non-motile. Thus according to Crawley, it seems strange why nature could have developed in the Polycystid gregarines a unique method of progression (as described by Schewiakoff) caused by the exudation of mucus when the muscular system is already present. Watson (1916) has also opposed Schewiakoff's theory and holds that the tail inhibits rather than promotes progression. In *S. bahli* also, it was clearly noted that with the increasing length and weight of the mucus-tail the speed of movement became slower and slower. If Schewiakoff's view is accepted, it is not understandable as to how the organisms would move when not even a trace of tail is noticed. It is, however, equally inexplicable, in actual observation, as to how the animal is able to drag forwards and cover a distance several times the total length of the tail formed by that time. It appears cogent that the mucus tail is not an aid but a definite impediment in the course of progression and is formed as an effect of locomotion rather than its cause.

According to Awerinzew (1910) both Schewiakoff's and Crawley's theories are objectionable.

Porter (1897), working on *Rhyncobolus americanus*, concluded, "It (locomotion) is probably caused by a very slight undulatory motion of the under surface of the animal". Lühe (1904), Paehler (1904), Schellack (1907), Voss (1922), Berlin (1924), Cognetti De Martiis (1927),

and others have supported Porter's theory. Roskin and Levinson (1929) could not observe slime exudation in *Nematocystis* sp. and *Polycystis* sp., and held that the contractions of the circular and longitudinal myonemes bring about locomotion in the same way as an earthworm moves through contractions of its longitudinal and circular musculature. Bowling has observed the thickening of the remarkable threads of *Zygocystis zonata*, both in the living and fixed material, but whether this indicates a cause or a result of movement is not clear. Sokolow (1912) believes, on the principle of a skyrocket, that locomotion is caused by the forceful expulsion of the fluid and contradicts Crawley's explanation of myonemic contractions. Watson (1916), from her studies on *Leidyana erratica*, has made a compromise between the two rival theories of Crawley and Sokolow by suggesting that the locomotion is caused by the myonemic contractions of that side of the animal which happens to be ventral at that time, mucus exudation merely creating friction as in the locomotion of *Limax*. Ray (1933) has confirmed Watson's explanation, excepting that he could not detect the continuity of the mucus-tail in *Stenophora khagendrae*. I agree with Watson's explanation but only for those gregarines which have developed a muscular system and not for forms like *Cephaloidophora communis* and *Chlamydocystis captiva*, which also move but possess a very feebly developed myonemic layer. In such cases undoubtedly, it is the forceful expulsion of the jelly-like substance which would take the leading part. In conclusion, it may be added that the phenomenon of movement cannot be attributed to a single cause: the type of movement, its speed and moving capacity are dependent upon the inter-action of several factors between the organism and its environment.

As regards the movements of gregarines within the body of the host certain authors have expressed the opinion that they do not move, as is evidenced by their dormant condition when an infected gut is teased and examined fresh. My observations also confirm the fact that they remain inactive in the gut-fluid even outside the body, but it is difficult to understand as to why there should have been a mechanism for locomotion at all. The probable cause of their inactivity in the exposed gut-fluid is due to the fluid becoming instantaneously viscid in the air, inhibiting the movements of the gregarines contained therein. It is probable, that the gregarines do move after detachment from the parasitised cells inside the body of the host in order to avail themselves of a greater range of nutrient material, and also to save themselves from being swept along with the food currents before encystment and that the bending movements of parasites chiefly help them in the formation of cysts.

Whether gregarines creep or swim different authors have expressed different opinions. For example, Crawley says, "Gregarines either lie against the under surface of the coverslip or upon the slide, which can be shown by raising or lowering the tube of the microscope. This shows that all studies on progression have been made on animals which are in contact with a surface." He has shown that a gregarine may be seen leaving the slide and coming upwards towards the coverslip: movement in this case having been effected by a contact of surface

(to creep upon) as offered by the extraneous particles present in the fluid. Mühl (1921) mentions that gregarines can crawl as well swim, depending upon the medium in which they are kept. I agree with Crawley's interpretation and it appears to me that in those gregarines in which the myonemes are well developed and mucus also exudes, creeping would be easier than swimming.

Summary.

(1) A new record of the genus *Stylocephalus* (*Stylorhynchus*) from India has been made, and an account of the life-history of *S. bahli*, sp. nov., found in *Gonocephalum helopioides* Frm. has been given in detail.

(2) This gregarine passes all its developmental stages outside the epithelial cells of the host, as no intra-cellular stage was encountered.

(3) Sporonts are solitary and associate by their anterior ends. Gametes are anisogamous. Spores are hat-shaped and are arranged in chains, each containing eight spindle-shaped or fusiform sporozoites.

(4) Dehiscence is either by pseudocyst or by a simple rupture.

(5) Infection is purely accidental, and there is evidence of seasonal intensity of infection.

(6) The phenomenon of polynuclearism—a rare occurrence in gregarines—has been observed in *S. bahli*.

(7) This gregarine seems to be susceptible to attacks of certain fungi belonging to the family Chytridiaceae which hyperparasitize its cytoplasm as well as its nucleus.

(8) The mechanism of movement in gregarines has been discussed and an account of the observations made upon the movement of *S. bahli* has been included.

(9) A comparison of the various species of *Stylocephalus* has been given in a tabulated form.

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EXPLANATION OF PLATE III.

Stylocephalus bahli, sp. nov.

FIG. 1.—Two young trophozoites attached to the epithelial cells of the host and showing faint indications of compartments on their bodies: ×1133.

FIG. 2.—A chain of macrogametes; × shows the entrance of a microgamete into the receptive spot of the macrogamete: ×625.

FIG. 3.—A sporont showing nuclear degeneration due to hyperparasitism: ×1200.

m.t., mucus-tail.

FIGS. 4, 5.—Sporonts showing polynuclearism: ×500.

FIG. 6.—An oblique section of the parasite showing the multi-nucleate amoeboid bodies (*see* text-fig. 13 *a*): ×900.

FIG. 7.—A portion of the gametocyst showing the completion of nuclear division in the male gametocyte (*m.*), whereas in the female (*f*) it is still in progress: ×350.

FIG. 8.—A transverse section of the gut of the host showing occlusion due to abundance of parasites therein: ×260.

1.

4.

2.

m.t.

3.

6.

8.

f.

m. 7.

Stylocephalus bahli, sp. nov.

CYCLOPOIDES NOUVEAUX DU CONTINENT INDO-IRANIEN, I.

Par KNUT LINDBERG.

Cyclopetta orientalis, sp. nov.

Description.—Longueur de la femelle ovigère environ 700µ ; offre l'aspect général d'un cyclopide, à tête parfaitement soudée au premier segment thoracique ; extrémité céphalique régulièrement arrondie, sans rostre apparent. Première antenne à 17 articles, rabattue elle atteint le tiers postérieur ou le bord postérieur du premier segment céphalothoracique. Un individu montrait une division incomplète du septième article. Deuxième antenne à 4 articles. Palpe mandibulaire à 2 branches. Abdomen assez étroit et allongé. Segment génital présentant

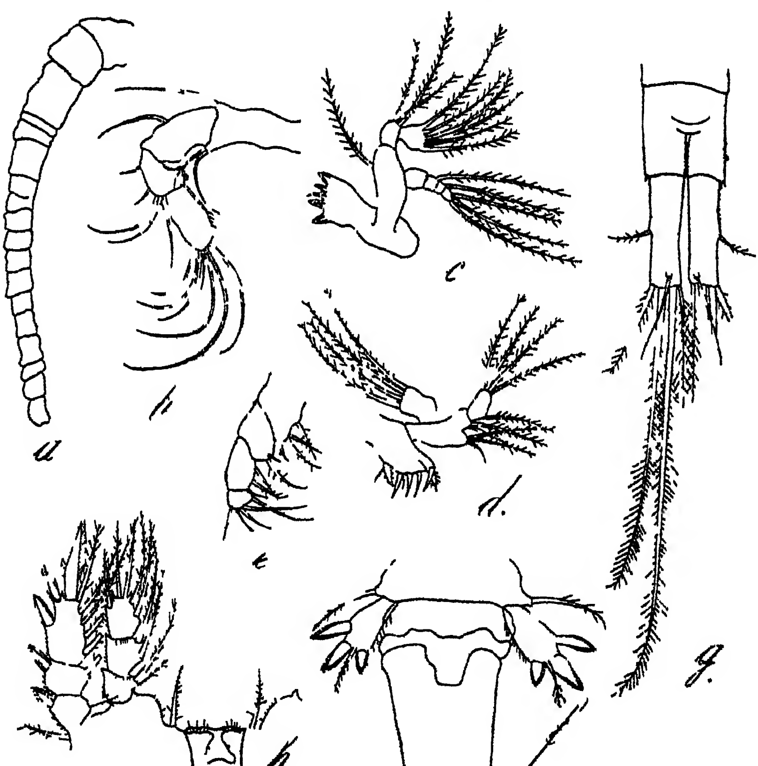

FIG. 1.—*Cyclopetta orientalis*, sp. nov. ♀

a. Première antenne ; *b.* Deuxième antenne ; *c.* Mandibule ; *d.* Maxille ; *e.* Deuxième maxillipède ; *f.* P 5 et segment génital, face ventrale ; *g.* Segment anal et furca, face dorsale ; *h.* P 4 et lamelle basale.

une échancrure dans son tiers antérieur ; il se rétrécit graduellement et légèrement dans sa partie distale. Segment anal plus long que le segment précédant. Opercule anal sans caractère distinctif. Furca

à branches parallèles, environ 4 fois aussi longues que larges. Soie latérale externe insérée un peu en avant du milieu de la branche. Soie apicale externe assez longue et très amincie ; elle est plus courte que la soie apicale interne. Soies apicales médianes à pennation légèrement hétéronyme. Pattes natatoires à branches tri-articulées. Formule des épines 4.4.4.3. Epines latérales et apicales des exopodites à structure lancéolée. Article terminal de l'enp. 4 court et trapu ; au lieu d'épines il porte deux soies apicales plus longues que l'article, la soie interne dépassant un peu en longueur celle de la soie externe. Lamelle basale de la quatrième paire de pattes munie de fines soies, à bord libre légèrement sinueux. P 5 formée d'un seul article, élargi en lamelle, portant 3 fortes épines ciliées et une mince soie. Bord latéral du cinquième segment thoracique pourvu d'une forte soie. Le réceptacle séminal semblait chez un des spécimens offrir l'aspect représenté sur la figure, mais les contours étaient très indistincts et il n'est pas certain que ce dessin donne une représentation correcte de sa structure. Ovisacs grands et allongés, écartés du corps ; ramenés vers l' abdomen ils atteignaient le tiers postérieur de la furca. Dans 3 ovisacs (chez deux individus) j'ai compté respectivement 25, 27 et 31 petits oeufs. Mâle inconnu.

Habitat.—J'ai récolté, au mois de décembre 1940, deux femelles ovigères dans des mares saumâtres peu profondes, près du bord de la mer à Pondichéry, et une jeune femelle dans une lagune à Oupalom, faubourg de Pondichéry, côte de Coromandel (Inde française).

Remarques.—La forme très remarquable qui vient d'être décrite appartient manifestement à la sous-famille des Cyclopininae de la famille des Cyclopinidae, puisqu'elle possède une deuxième antenne à 4 articles. Par suite de sa palpe mandibulaire à 2 branches et P 5 à un seul article, il convient de la ranger dans le genre de *Cyclopetta* de Sars, bien qu'elle diffère considérablement à plusieurs égards de l'espèce pour laquelle a été créé ce genre, espèce unique connue jusqu'à présent, pour autant que je le sache, le *Cyclopetta difficilis* de Sars.

Cyclopetta orientalis, sp. nov. ♀.

Longueur μ	Largeur μ	Long. 1	segm. 2	3	abdom. 4	Furca Long. : larg. :	Furca Soie dors.	Furca Soies apicales.	Enp. 4. Art. 3 Long. : larg.	Enp. 4. Art. 3 Soie ap. int. : soie ap. ext.
732	237	105	43	33	53	(30+33): 16=3·94:	1 ..	58 : 187 : 254 : 72	25 : 19=1·32 : 1	47 : 43=1·09 : 1
703	237	105	42	28	48	(32+33) :16=4·06:	1 58	63 : 192 : 259 : 70	26 : 20=1·30 : 1	42 : 37=1·13 : 1
627	237	105	37	27	47	(30+32). 16=3·87:	1 53	62 : 187 : 255 : 70	26 . 18=1·44 : 1	43 : 38=1·13 : 1

Eucyclops farsicus, sp. nov.

Description.—Longueur de la femelle ovigère environ 800μ (de 769 à 836μ). Ailes latérales du cinquième segment thoracique munies de fortes soies. Quelques individus ont montré les bords postérieurs des trois premiers segments abdominaux découpés sur la face ventrale en petites dents ; chez d'autres, cette caractéristique n'a pas été observée.

Rebord distal du quatrième segment abdominal portant sur la face ventrale la rangée usuelle de petites épines, qui s'étend aussi sur les parties latérales de la face dorsale. Echancrure anale pourvue de petits poils très fins. Branches de la furca le plus souvent bien divergentes, en moyenne de 3·74 fois aussi longues que larges. Serra très courte, composée de 2 à 7 petites spinules, placées à proximité de la soie latérale externe ; les spinules les plus distales semblent parfois un peu plus longues que les autres. Soie dorsale de longueur intermédiaire entre celle de la soie apicale externe et celle de la soie apicale interne (longueur moyenne 54μ). Soie apicale externe assez forte et grosse, munie de cils

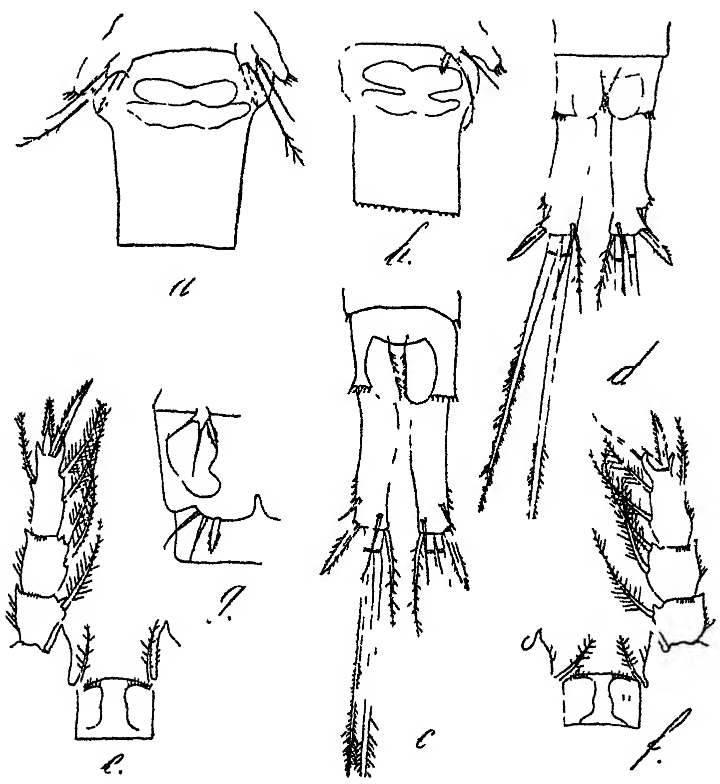

FIG. 2.—*Eucyclops farsicus*, sp. nov.

a. ♀ P 5 et segment génital, face ventrale ; *b.* ♀ Do. Autre exemplaire ; *c.* ♀ Segment anal et furca, face dorsale ; *d.* ♀ Do. Autre exemplaire ; *e.* ♀ Endopodite et lamelle basale P 4 ; *f.* ♀ Do. Autre exemplaire ; *g.* ♂ P 5 et P 6.

courts ; soie apicale interne considérablement plus longue que la soie apicale externe (rapport de 1·58 : 1 à 2·03 : 1, moyenne 1·79 : 1). Les deux soies apicales médianes régulièrement pourvues de cils de longueur moyenne, très serrés sur les parties distales. Première antenne à 12 articles, rabattue elle atteint le milieu ou le tiers postérieur du deuxième segment thoracique. Sur les trois derniers articles se trouve une membrane hyaline étroite et entière. Formule des épines 3·4·4·3 Les

épines latérales et apicales des pattes natatoires montrent des bords amincis et étalés, structure décrite d'abord par Sars chez *E. euacanthus*. Article terminal de l'enp. 4 plus de deux fois aussi long que large (rapport moyen 2·24 : 1). Les deux épines apicales de cet article offrent aussi l'apparence en lancette déjà mentionnée, qui peut cependant être peu évidente chez l'épine apicale interne par suite de la torsion qu'elle présente le plus souvent. Cette épine est en général légèrement plus longue que l'article qui la porte (rapport moyen épine apicale interne : article 1·06 : 1), mais elle dépasse toujours considérablement en longueur celle de l'épine apicale externe (rapport moyen épine apicale interne : épine apicale externe 1·32 : 1). Lamelle basale de la quatrième paire de pattes pourvue des longues soies usuelles. P. 5 ressemble à celle d'*E. agiloides* ; la largeur de l'épine interne est environ deux fois celle de la soie médiane. Réceptacle séminal montrant le plan général usuel du groupe ; deux aspects différents sont représentés sur les figures. Ovisacs peu volumineux, très légèrement écartés du corps ; ramenés vers l'abdomen ils atteignent le plus souvent le tiers antérieus ou le milieu de la branche de la furca. Ils contiennent de 4 à 6 gros oeufs.

Mâle, longueur moyenne 642µ. Branches de la furca parallèles, sans serra ; rapport moyen entre la longueur et la largeur de 3·47 : 1. P 6 formée d' une épine interne, forte mais courte, qui peut atteindre le bord postérieur du deuxième segment abdominal, d'une soie médiane, le plus souvent un peu plus longue que l'épine et d'une mince soie externe de direction oblique. Longueur moyenne de l'épine interne 28µ.

Habitat.—Un étang d'eau douce à végétation abondante à Baba Hadji, localité située à 30 kilomètres au sud de Chiraz (province de Fars), à une altitude d'environ 1500 m. Récolté au mois de mars.

Remarques.—Pour autant qu'il me soit connu aucun *Eucyclops* n'a été présenté jusqu'à présent avec lequel l'espèce qui vient d'être décrite puisse être comparée. Kiefer a bien fait connaître un *Eucyclops* à serra très courte et possédant des épines de l'enp. 4 montrant un aspect en lancette l'*E. permixtus*, trouvé dans le Pendjab, et Kiefer dit avoir retrouvé cette même forme chez des animaux rapportés de 6 localités de l'Est de Java [d'après la figure No. 48 les épines en question ont cependant une apparence ordinaire, tandis quelles sont très " lancéo lées " sur la figure de la description originale (Kiefer 1928).] La structure de la furca et de ses appendices, celle de l'article 3 de l'enp. 4, celle de P 5 etc. montrent cependant qu'il s'agit d'une forme nettement distincte d' *E. farsicus*. Chez *E. permixtus* la première antenne est plus courte, l'article terminal de l'enp. 4 beaucoup moins allongé, l'épine apicale interne bien plus longue par rapport à l'article ; l'épine de P 5 considérablement plus longue et effilée. Une caractéristique très frappante qui permet au premier coup d'oeil et sans autre examen de distinguer l'*E. farsicus* non seulement du *E. permixtus* mais aussi de la forme suivante, c'est la structure de l'épine apicale externe de la furca ; courte, grosse et presque obtuse, à cils très courts chez *E. farsicus*, bien différente de l'épine apicale externe longue et amincie figurée par Kiefer chez *E. permixtus*.

Eucyclops farsicus, sp. nov.

Longueur μ	Furca Long. : larg.	Furca Soies apicales	Enp. 4. Art. 3 Long. : larg.	Enp. 4 Art. 3 Ep. ap. int. : ép. ap. ext.	Enp. 4. Art. 3 Ep. ap. int. : art.	P 5 Epine : soie (larg. approx.)	P 6 Epine : soie méd. : soie ext.
♀ 798	83 : 22=3·77 : 1	33 : 220 : 370 : 63	52 : 22=2·36 : 1	52 : 43=1·21 : 1	52 : 52=1 : 1	2 : 1	
836	87 : 23=3·78 : 1	37 : 220 : 374 : 67	52 : 23=2·26 : 1	58 : 43=1·35 : 1	58 : 52=1·12 : 1	2 : 1	
864	85 : 23=3·69 : 1	42 : 203 : 375 : 75	50 : 23=2·17 : 1	53 : 40=1·32 : 1	53 : 50=1·06 : 1	1·5 : 1	
769	80 : 22=3·63 : 1	38 : 217 : 370 : 60	50 : 23=2·17 : 1	55 : 42=1·31 : 1	55 : 50=1·10 : 1	2 : 1	
779	83 : 22=3·77 : 1	33 : 202 : X : 62	50 : 20=2·50 : 1	53 : 42=1·26 : 1	53 : 50=1·06 : 1	..	
817	90 : 23=3·91 : 1	38 : 214 : 347 : 67	52 : 23=2·26 : 1	55 : 40=1·37 : 1	55 : 52=1·06 : 1	2 : 1	
798	87 : 23=3·78 : 1	40 : 228 : X : 67	50 : 23=2·17 : 1	53 : 38=1·39 : 1	53 : 50=1·06 : 1	2 : 1	
788	83 : 22=3·77 : 1	37 : 203 : 340 : X	50 : 22=2·27 : 1	52 : 40=1·30 : 1	52 : 50=1·04 : 1	..	
..	78 : 22=3·54 : 1	33 : X : X : 67	45 : 22=2·04 : 1	48 : 35=1·37 : 1	48 : 45=1·06 : 1	1·8 : 1	
♂ 746	75 : 16=4·69 : 1	33 : X : X : 50	41 : 17=2·41 : 1	52 : 40=1·30 : 1	52 : 41=1·27 : 1	..	33 : 30 · 41
613	58 : 18=3·22 : 1	22 : 150 : X : 50	..	..	..	..	28 : 27 : 33
608	57 : 17=3·35 : 1	22 : 153 : 307 : 50	..	..	..	..	27 : 28 : 30
613	56 : 18=3·11 : 1	23 : 147 : X : 47	..	..	..	..	27 : 30 : 33
646	60 : 18=3·33 : 1	23 : 148 : X : 42	42 : 18=2·33 : 1	47 : 35=1·34 : 1	47 : 42=1·12 : 1	..	28 : 27 : 30
..	..	..	..	..	..	..	33 : 30 : 41
627	58 : 18=3·22 : 1	25 : 163 : 305 : 50	40 : 19=2·10 : 1	43 : 33=1·30 : 1	43 : 40=1·07 : 1	..	25 : 28 : 30

Eucyclops ruttneri forma **elburziensis,** nov.

Description.—Longueur de la femelle adulte de 760 à 940μ (moyenne de 8 individus 862μ). Ailes latérales du cinquième segment thoracique portant de fortes soies. Une indentation du bord postérieur des trois premiers segments abdominaux a été observée chez quelques exemplaires, mais elle ne semble pas être constante. Quatrième segment abdominal muni sur la face ventrale du rebord postérieur d'une rangée de petites épines. De très fins poils s'aperçoivent au fort grossissement au niveau de l'échancrure anale. Branches de la furca plus ou moins divergentes, en moyenne de 3·63 fois aussi longues que larges. Serra rudimentaire, composée de 4 à 10 spinules, dont les plus distales sont en général légèrement plus longues que les autres. Soie dorsale (longueur moyenne 52μ) le plus souvent plus courte que la soie apicale externe. Celle-ci assez longue et effilée (longueur moyenne 60μ), portant de longs cils. Rapport moyen entre la longueur de la soie apicale interne et celle de la soie apicale externe de 1·35 : 1. Les deux soies apicales médianes munies de longs cils dont la disposition plus lâche que chez l'espèce précédante se voit sur la figure. Première antenne à 12 articles, rabattue elle atteint le bord postérieur du premier segment céphalothoracique et parfois le milieu du deuxième segment thoracique. Trois

FIG. 3.—*Eucyclops ruttneri* forma *elburziensis,* nov.

a. ♀ P 5 et segment génital, face ventrale ; *b.* ♀ Do. Autre exemplaire ; *c.* ♀ Segment anal et furca, face dorsale ; *d.* ♀ Endopodite et lamelle basale P 4 ; *e.* ♂ P 6.

derniers articles pourvus d'une membrane hyaline étroite et entière. Les épines des branches des pattes natatoires ont toutes une structure ordinaire ; chez aucun des spécimens examinés je n'ai vu une apparence

lancéolée. Formule des épines 3.4.4.3. Article terminal de l'enp. 4 le plus souvent à peu près 2 fois aussi long que large (rapport moyen 1·98 : 1, mais amplitude de variation très grande allant de 1·68 : 1 à 2·40 : 1). Epine apicale interne toujours considérablement plus longue que l'article (rapport moyen épine apicale interne : article=1·23 : 1) ; elle est aussi beaucoup plus longue que l'épine apicale externe (rapport moyen épine apicale interne : épine apicale externe=1 71 : 1). Lamelle basale de la quatrième paire de patte munie de longues soies sans caractères distinctifs. P 5 ressemblant à celle de l'espèce précédante ; largeur de l'épine cependant parfois encore plus considérable, pouvant atteindre 2·5 fois celle de la soie médiane. Deux aspects un peu différents du réceptacle séminal ont été observés également chez cette espèce et ont été représentés sur les figures. Ovisacs plus volumineux que chez *E. farsicus*, légèrement écartés du corps ; ramenés vers l'abdomen ils dépassent souvent l'extrémité de la furca. J'ai compté de 4 à 15 oeufs dans chaque sac ; en moyenne il y en a eu de 7 à 8.

Mâle, longueur moyenne 722µ. Branches de la furca parallèles ; 3 ou 4 petites spinules se trouvent placées à peu près sur le même niveau à proximité de l'insertion de la soie latérale externe. Les branches de la furca étaient chez les 3 individus examinés moins de 3 fois aussi longues que larges. P 6 composée d'une forte épine interne qui, chez les 3 spécimens, atteignait ou dépassait légèrement le rebord postérieur du deuxième segment abdominal : d'une soie médiane plus courte que l'épine et d'une mince soie externe. Longueur moyenne de l'épine interne 43µ.

Habitat.—Des mares de torrent dépourvues de végétation à Derbend (Chémiran, 14 kilomètres au nord de Téhéran) et à Pasqaléh (2 kilomètres plus au nord), ces deux localités se trouvant sur le versant sud du massif de l'Elbourz, à une altitude d'environ 1350 m. Récolté en petit nombre au mois d'octobre.

Remarques.—La forme dont il vient d'être question ressemble à certaines autres espèces peu connues, décrites d'après des spécimens uniques ou de nombre réduit et rapportées de localités isolées ou de régions circonscrites. Il s'agit d'animaux ressemblant beaucoup à de petits *E. serrulatus* (Fischer) mais possédant une serra se réduisant à un très petit nombre de spinules. Du *E. hadjebensis* (Kiefer), récolté au Maroc, notre espèce semble se différencier par la largeur moins grande de l'épine de P 5 et par l'épine ventrale plus longue de P 6 chez le mâle. *E. defectus* Lindberg, trouvé dans l'Inde centrale, possède aussi une épine de P 5 plus large et il a des branches de la furca plus longues. L'espèce qui lui ressemble le plus à juger d'après la description et les figures est *E. ruttneri* Kiefer, de Sumatra et de Java. Cependant il ne semble pas admissible de l'identifier avec celui-ci : la structure de la cinquième patte en diffère, notamment en ce qui concerne l'épine et aussi la configuration de l'article terminal de l'enp. 4, dont l'épine apicale interne est considérablement plus longue que l'article chez *elburziensis*, tandis que cette épine égale parfois en longueur celle de l'article ou ne la dépasse que légèrement chez *E. ruttneri*. Cependant, par suite des grandes analogies, il est présenté ici comme une forme d'*E. ruttneri*, mais cela à titre provisoire, à cause de l'impossibilité dans laquelle je me trouve à comparer les deux formes. Dans le cas d'une étude comparative de

Eucyclops ruttneri forma *elburziensis*, nov.

Localité	Longueur μ	Furca Long. : larg.	Furca Soies apicales.	Enp. 4. Art. 3 Long. : larg.	Enp. 4. Art. 3 Ep. ap. int. : ép. ap. ext.	Enp. 4. Art. 3 Ep. ap. int. : art.	P 5 Epine : soie larg. (approx.)	P 6 Epine : soie méd. : soie ext.
Derbend .	♀ 798	82 : 24=3·42 : 1	60 : 284 : X : 73	44 : 22 2 : 1	55 : 30 1·83 : 1	55 : 44 1·25 : 1	2 : 1	
	804	85 : 24=3·54 : 1	58 : 287 : 446 : 73	47 : 22 =2·11 : 1	58 : 33 1·76 : 1	58 : 47– 1·23 : 1	2 : 1	
	760	70 : 23=3·04 : 1	47 : 217 : 417 : 65	42 : 21 =2 : 1	53 : 30 =1·77 : 1	53 : 42=1·26 : 1	2 : 1	
	931	97 : 26=3·73 : 1	62 : 295 : 466 : 82	47 : 25– 1·88 : 1	60 : 37=1·62 : 1	60 : 47 =1·28 : 1	2 : 1	
	931	108 : 27=4 : 1	73 : X : X : 88	50 : 26 =1·92 : 1	58 : 37– 1·57 : 1	58 : 50 =1·16 : 1	2·5 : 1	
	883	97 : 27=3·59 : 1	63 : 290 : 459 : 108	47 : 28=1·68 : 1	63 : 35=1·80 : 1	63 : 47=1·34 : 1	1·8 : 1	
	940	102 : 28=3·64 : 1	70 : 314 : 514 : 85	53 : 27– 1·96 : 1	62 : 38 =1·63 : 1	62 : 53—1·17 : 1	..	
	♂ 675	57 : 20=2·85 : 1	42 : 208 : 384 : 77	35 : 20 =1·75 : 1	47 : 27=1·74 : 1	47 : 35=1·34 · 1	.	43 : 30 : 38
	760	67 : 23=2·91 : 1	42 : 250 : 414 : 75	40 : 18=2·22 : 1	50 : 31=1·61 : 1	50 : 40=1·25 . 1	..	45 : 37 : 37
	731	63 : 22=2·86 : 1	43 : X : X : 80	..	..	..	..	42 : 37 : 43
Pasqaléh .	♀ 855	92 : 23=4 : 1	60 : 250 : 424 : 78	53 : 22=2·40 : 1	62 : 35=1·77 : 1	62 : 53=1·17 : 1	..	

matériel suffisant il faut évidemment admettre aussi la possibilité d'arriver à la conclusion, soit, que les deux formes sont identiques, soit, qu'il convient de les séparer comme des espèces différentes ; et peut-être cette dernière éventualité sera-t-elle la plus probable. Les Cyclopides de vastes régions de l'Inde sont maintenant assez bien connus, mais jusqu'à présent je n'ai trouvé nulle part dans l'Inde un *Eucyclops* ressemblant à *E. ruttneri*. Conséquemment l'agent de liaison géographique, pour ainsi dire, semble manquer entre les animaux des deux régions respectives, les îles de la Sonde sous l'équateur et le Nord du plateau de l'Iran dans la latitude 36°, régions de caractères bien opposés. Du reste, ce ne sera bien entendu que le jour quand nous connaîtrons complètement les nombreux *Eucyclops* du globe entier qu'il sera possible d'assigner leur place réelle aux divers *Eucyclops* à serra rudimentaire qui ont été mentionnés ici.

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SILUROID FISHES OF INDIA, BURMA AND CEYLON

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XI. FISHES OF THE SCHILBEID GENERA *SILONOPANGASIUS* HORA, *PSEUDEUTROPIUS* BLEEKER, *PROEUTROPIICHTHYS* HORA, AND *AILIA* GRAY.

As the family Schilbeidae is represented by several genera in the Ethiopian and Oriental zoogeographical regions, it was my[1] intention to give a comprehensive account of the classification, distribution, ecology and evolution of these fishes, but considerable difficulty was experienced in carrying out this plan, partly owing to the great confusion that prevailed in the taxonomy of the Indian genera and species of this family, and partly because of the absence of African material in the collection of the Indian Museum for comparison with the Indian forms. Accordingly, the Indian genera have now been revised one by one and the generic limits of *Eutropiichthys* Bleeker[2] [*E. goongwaree* (Sykes), *E. vacha* (Hamilton) and *E. murius* (Hamilton)], *Clupisoma* Swainson[3] [*C. garua* (Hamilton), *C. prateri* Hora and *C. montana* Hora], *Silonia* Swainson[4] [*S. silondia* (Hamilton)], *Pangasius* Cuvier and Valenciennes[5] [*Pangasius pangasius* (Ham.)]; *Helicophagus* Bleeker[6] and *Platytropius* Hora[7] have already been elucidated. The taxonomy of the Indian species included in these genera has also been dealt with. This article deals with a systematic account of the remaining Indian genera of the Schilbeidae.

Key to the Indian genera of Schilbeidae.

I. Two barbels (maxillary); teeth caniniform; air-bladder[8] greatly reduced .. .. .. *Silonia* Swainson.

II. Four or eight barbels.

- A. Four barbels; one pair maxillary, one pair mandibular.
  1. Caniniform teeth in jaws; air-bladder greatly reduced, without any caecum at the posterior end .. .. *Silonopangasius* Hora.
  2. Small, villiform teeth in jaws; air-bladder[9] large or of moderate size, usually with a caecum at the posterior end .. .. .. *Pangasius* Cuv. & Val.

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[7] Hora, S. L., *Journ. Siam. Soc. Nat. Hist.* Suppl. XI, pp. 39-46 (1937).
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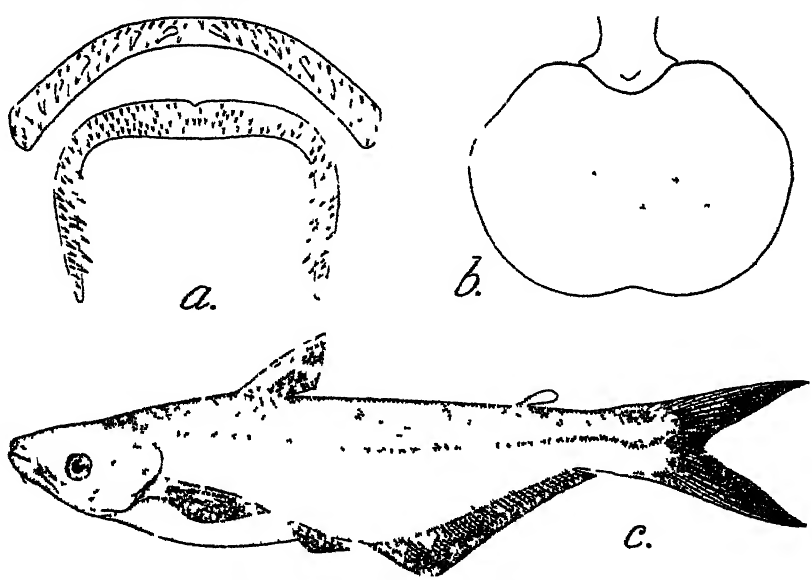
[9] Nair, K. K., *ibid.* XXXIX, pp. 117-124 (1937).

B. Eight barbels, one pair maxillary, two pairs mandibular, one pair nasal
  1 Teeth on palate in two small widely separated patches, sometimes connected by a linear series
    a Rayed dorsal present, air-bladder large, forming blister-like areas above pectorals ... *Pseudeutropius* Blkr
    b Rayed dorsal present; air bladder[1] greatly reduced, tubular, partly covered by bone . . .. *Ailia* Gray
  2 Teeth on palate in four distinct contiguous patches or in a broad band sometimes interrupted in the middle
    a Teeth on palate in four distinct patches, air-bladder of moderate size . *Proeutropiichthys* Hora.
    b Teeth on palate in two extensive patches separated in the middle or in a continuous horse-shoe-shaped band
      i Maxillary and palatine teeth greatly produced backwards at the sides, air bladder[2] greatly reduced, tubular . *Eutropiichthys* Blkr
      ii Maxillary and palatine teeth not produced backwards, air bladder[3] greatly reduced, but not tubular . *Clupisoma* Swainson

Silonopangasius Hora.

1937. *Silonopangasius*, Hora, *Cur Sci.* V, p 352.

The genus *Silonopangasius* was proposed for *Ageneiosus childreni* Sykes.[4] This species, as I understand it, possesses caniniform teeth in the jaws and a pointed lower jaw, as in *Silonia*, and four barbels—one



Text-fig. 1.—*Silonopangasius childreni* (Sykes).

a. Dentition: × 3; *b*. Air-bladder × 3; Lateral view of a specimen from the Bhavani River: × ⅗.

[1] Nair, K. K., *Rec. Ind. Mus.* XL, pp. 185, 186 (1938).
[2] Nair, K. K., *ibid.* XL, pp. 183-185 (1938).
[3] Nair, K. K., *ibid.* XL, pp. 186, 187 (1938).
[4] Sykes, W. H., *Trans. Zool. Soc London* II, p. 375 (1841).

pair maxillary and one pair mandibular—as in *Pangasius* The air-bladder, though small and somewhat thick-walled, is considerably larger than that of *Silonia*; it is oval in outline with the longer axis transversely disposed. On account of the structure of the air-bladder and the presence of a pair of mandibular barbels this species cannot be referred to *Silonia* or to *Pangasius* and has accordingly been placed in a separate genus.

Ageneiosus childreni was characterised by Sykes as follows:

> "An *Ageneiosus*, without cirri; with the first ray of the dorsal and pectoral fins serrated on the interior edge only: with eight rays in the dorsal and 42 in the anal fin; with two sharp lobes to the tail, the upper being somewhat the smallest."

Sykes mentioned the length of his specimen as 18 inches and remarked "flesh sweet and juicy, but not firm". As regards the affinities of his spicees he stated.

> "A comparison of my drawing with the description of *Ageneiosus mino* of Dr. Hamilton's 'Fishes of the Ganges', will show how many features there are in common between it and the *Parree*; but its height and compressed body, and the extent of the anal fin, at once fix the latter as a distinct species Found in the Mota Mola river, at Poona. *Pimelodus silonda* (*sic*) of Buchanan Hamilton (Tab. VII, fig. 50) is also an *Ageneiosus*."

The serrations along the anterior borders of the dorsal and the pectoral fins are obviously incorrectly shown in the figure of the species which most probably served for Sykes' description. Serrations are invariably present in Siluroid fishes along the inner borders of the spines, and the outer border may be smooth or serrated.

Jerdon,[1] who included this species in his list of fishes of Southern India, referred it to the genus *Silundia* and remarked:

> "I have very little doubt that this is a true *Silundia*, and perhaps the *S. Gangetica* though Sykes says there are no cirri, for it appears that the two small cirri which are present in that fish are made out sometimes with difficulty"

Günther[2] included Sykes' species in the synonymy of *Silondia gangetica* without any comments; while Day[3], when describing *Silundia sykesii*, made the following observations regarding this species:

> "Sykes states that this fish is termed *Parree* Mahr and *Sillun* in the Deccan, that it is *without cirri*, and also that the first bony ray is 'serrated' on the anterior edge", such being also shown in the figure. This last observation leads me to believe that he described from the drawing, which seems to have maxillary barbels indistinctly marked.
> "The long maxillary barbels of this species [*S. sykesii*] at once serve to distinguish it from the *S gangetica*, C. V."

The air-bladder of *S. sykesii* is described as "transverse, not enclosed in bone."

Day also referred to the presence of the mandibular barbels in *S. sykesii* and their absence in *S. gangetica* and came to the conclusion that no generic importance should be attached to this character. The generic distinction between the two species, however, rests mainly on the character of the air-bladder.

I have examined several examples of *Silonopangasius childreni* (Sykes). Three specimens (Nos. 1230, 1285, 8903) were purchased from Day and two out of these are labelled in Day's handwriting as *Silundia sykesii*; these are 123 mm., 180 mm., and 200 mm. in standard length

[1] Jerdon, T. C., *Madras Journ. Litt. & Sci* XV, p. 340 (1849).
[2] Gunther, A., *Cat Fish. Brit. Mus.* V, p. 65 (1864).
[3] Day, F, *Journ. Linn. Soc. Zool.* XII, p. 569 (1876).

respectively. Recently 3 adult specimens were received from the Mota Mola river, the type-locality, and in 1918 the late Dr. N. Annandale had collected a large number of young specimens from the edge of the Godavari river at Rajahmundry in the Madras Presidency. So far as is known at present, the species is found in Deccan only.

As a result of the examination of the above noted material I am fully convinced that Day's *Silundia sykesii* is synonymous with Sykes's *Ageneiosus childreni*. The following table of measurements gives some idea of the range in variation of proportions, etc.

Measurements in millimetres.

	Bhavani R.		Godavari R.	Madras.		Deccan.		Poona.		
Total length	256·0	165·0	81·0	..	220·0	332·0	..	338·0	323·0	300·0
Standard length	199·0	138·0	61·5	197·0	170·0	271·5	123·5	271·5	255·0	235·0
Length of head	50·0	31·0	16·0	45·0	42·0	63·0	28·8	64·0	57·0	55·0
Width of head	31·0	18·0	11·0	25·0	23·0	40·0	15·0	35·3	31·0	29·0
Width of body	26·0	14·0	7·5	20·0	17·0	30·0	11·0	38·0	30·0	25·0
Height of body	49·0	30·0	13·5	40·0	37·0	57·0	21·5	62·0	57·0	55·0
Diameter of eye	13·2	9·5	5·5	13·0	12·5	17·0	9·0	17·0	16·0	14·8
Interorbital width	21·0	10·0	5·5	15·5	13·0	21·0	10·0	21·6	19·0	18·0
Length of snout	17·0	12·0	5·5	15·0	14·5	21·0	9·0	23·0	20·0	19·0
Length of maxillary barbel ..	12·0	11·0	12·0	16·0	15·5	28·0	15·5	31·0	26·0	25·0
Length of mandibular barbel ..	1·0	1·2	5·5	4·0	5·0	6·0	5·0	9·0	7·0	6·5
Length of dorsal spine ..	32·0	20·0	9·0	D.	D.	38·0	19·0	38·0	D.	D.
Length of pectoral spine ..	36·0	22·0	11·0	35·0	33·0	40·0	21·0	52·0	48·0	45·0
Least height of caudal peduncle.	18·0	11·0	5·0	16·0	15·5	20·0	10·5	25·0	20·0	20·0

Pseudeutropius Bleeker.

The genus *Pseudeutropius* was proposed by Bleeker[1] in the group Pangasii to accommodate *Eutropius brachypopterus* Blkr. and was characterised as follows:

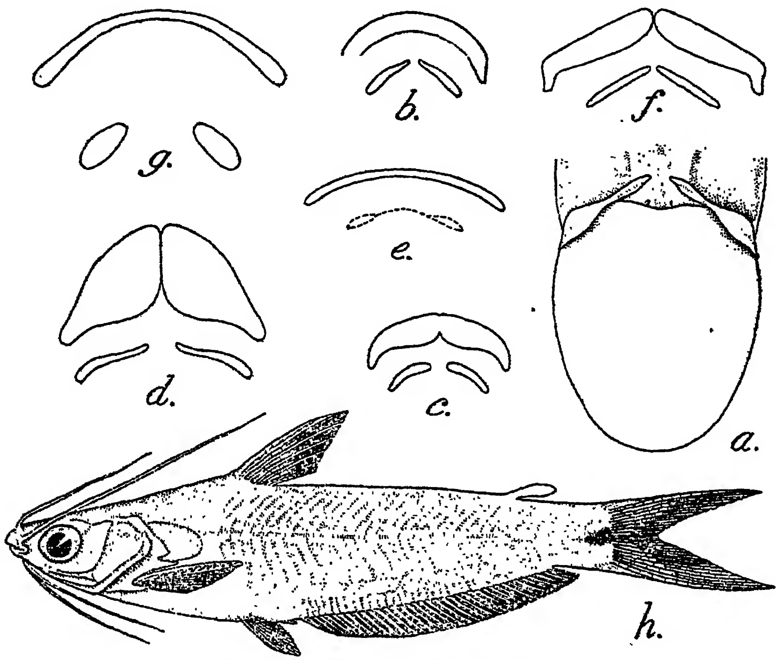
"Cirri 8, nasales 2, supramaxillares 2, inframaxillares 4. Dentes maxillis pluriseriati. Dentes vomerini in vittam transversam dispositi, palatini distincti nulli. Cirri inframaxillares omnes margini maxillae anteriori valde approximati. B. 10."

A year later Bleeker[2] revised this definition and stated "Dentes vomero-palatini in vittam transversam indivisam dispositi."

The chief points of differences between *Eutropius* and *Pseudeutropius* are: (i) The mandibular barbels are situated at a considerable distance from the anterior margin of the lower jaw in *Eutropius* and close to the margin in *Pseudeutropius*. (ii) In *Eutropius* the mandibular barbels are placed one pair behind the other, whereas in *Pseudeutropius* both the pairs are in a more or less straight line. (iii) The vomerine and palatine patches of teeth are distinct, though contiguous, in *Eutropius*; while in *Pseudeutropius* the vomero-palatine patches are transversely disposed and the vomerine teeth are indistinguishable from the palatine teeth.

[1] Bleeker, P., *Versl. Akad. Amsterdam* XIV, p. 398 (1862).
[2] Bleeker, P., *Ned. Tijdschr. Dierk.* I, p. 106 (1863).

A study of the descriptions of the species included by Günther[1] and Day[2] under *Pseudeutropius* shows that they paid little attention to the limits proposed by Bleeker for this genus with regard to the dentition of its members. For instance, in the six species referred by Günther to this genus the vomerine teeth are stated to " form a very narrow band, which is angularly bent, and continuous with the palatine teeth " in *P. brachypopterus*, the type of the genus and of which Günther had a typical specimen from Bleeker's collection; while the dentition of *P. atherinoides*, *P. mitchelli* and *P. goongwaree* is not described. In



Text-fig. 2.—*Pseudeutropius* Bleeker.

a. Air-bladder of *P. atherinoides* (Bloch), from a specimen 53 mm. in standard length : ×4⅗ ; *b.*, *c.* and *d.* Dentition of three specimens of *P. atherinoides* (Bloch), 57 mm., 74 mm. and 100 mm. in standard length respectively : *b* : ×6 ; *c* : and *d* : ×4 ; *e.* Dentition of type-specimen of *P. brachypopterus* (Bleeker) after a sketch by Mr. J. R. Norman ; *f.* Dentition of *P. mitchelli* Günther after a sketch by Mr. J. R. Norman ; *g.* Dentition of a specimen (No. 430) of *P. mitchelli* Günther, 96 mm. in standard length ; *h.* Lateral view of a specimen (Cat. No. 502) of *P. atherinoides* (Bloch).

P. megalops, the teeth of the vomer form two quadrangular patches, which are separated from each other by a linear groove ; the palatine teeth form a cuneiform band which is subcontinuous with the vomerine teeth." In *P. longimanus*, " the vomerine band is interrupted in the middle, each half being subcontinuous with the palatine band." Taking into consideration the character of dentition it is clear that whereas there is considerable similarity between *P. megalops* and *P. longimanus*, both of these differ from *P. brachypopterus*, and should not be included under *Pseudeutropius* (*sensu stricto*).

[1] Günther, A., *Cat. Fish. Brit. Mus.* V, pp. 58-61 (1864).
[2] Day, F., *Fish. India*, pp. 470-474 (1877).

Day in his " Fishes of India " included seven species under *Pseudeutropius* ; of all of these I have examined specimens determined by him. Though there are inaccuracies in his descriptions and figures of the dentition of the various species, I shall, for the point under discussion, refer to the account as given by him. In *P. goongwaree*, the teeth are " in a wide pyriform band wider than those in the jaws, the vomerine and palatine groups touching, but the two vomerine patches having a short interspace between them." In *P. taakree*, the vomerine and palatine teeth are in distinct patches. In *P. acutirostris*, the teeth are " in two minute patches on the vomer, and of the same character on the palatines, which are not continuous with those on the vomer." In *P. murius*, the teeth " on the vomer and palate form an almost uninterrupted semilunar band." The teeth on the palate of *P. sykesi* are " in two distinct patches." In *P. atherinoides*, there is " a narrow, uninterrupted, crescentic band across the palate," while in *P. garua* the teeth are " in a semilunar band across the palate, those of the vomer contiguous to those of the palatines, and each patch being semicircular internally : sometimes the two vomerine patches have an interspace between them." The great variation in the dentition of these species clearly shows that *Pseudeutropius*, as recongnised by Day, is a composite genus.

It is also clear from the above that dentition alone is not sufficient for the proper differentiation of the genus *Pseudeutropius*. I have, however, found that if this feature is coupled with the nature of air-bladder, it is possible to differentiate and define more precisely this and the allied Schilbeid genera occurring in India.

For determining the precise limits of the genus *Pseudeutropius*, I requested Mr. J. R. Norman to examine the type-specimen of *Pseudeutropius brachypopterus*, the type of the genus. He sent me a sketch of its dentition (Text-fig. 2*e*), and remarked that the specimen is in a poor condition and, in consequence, he had great difficulty in making out the outlines of the tooth-bands. According to Weber and de Beaufort[1] the dentition of *P. brachypopterus* consists of " Minute teeth in narrow bands on the jaws ; on the vomer in two small patches connected by an angular line of teeth ". Unfortunately no account has so far been published of the air-bladder in this species, but it seems probable that it is a large, thin-walled structure which laterally comes in contact with the skin and forms translucent, blister-like areas above the pectoral fins. Weber and de Beaufort (*op. cit.*) described another species of *Pseudeutropius*—*P. moolenburghae*—from Sumatra in which they found " Teeth minute, in the jaws in a narrow band, on the vomer in two widely separate elliptic patches." Its figure shows the translucent area above the pectoral fin, though there is no reference to the nature of the air-bladder in the description.

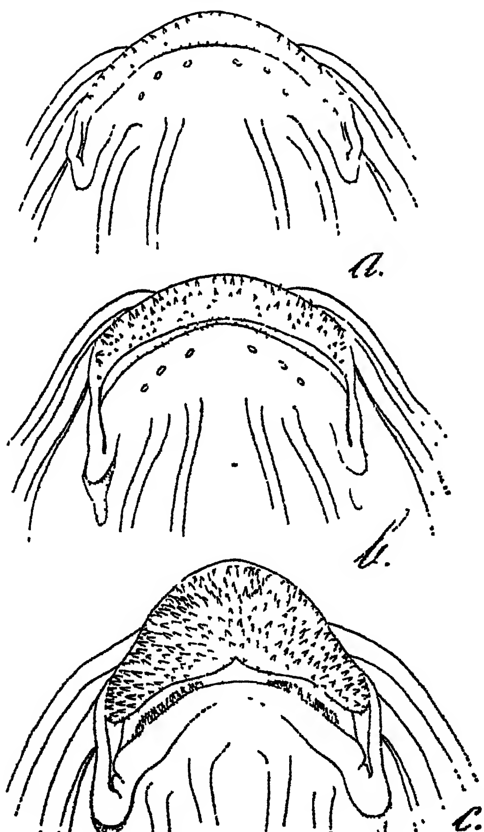
As judged from the material in the collection of the Indian Museum, it seems that *Pseudeutropius* is represented in the Indian waters by *P. atherinoides* (Bloch)[2] and *P. mitchelli* Günther[3] ; both the species possess vomerine teeth in two distinct patches which may be small or

[1] Weber M. and Beaufort, L. F. de, *Fish. Indo-Austral. Archipel* II, p. 249 (1913).
[2] Bloch, M. E., *Naturges. Ausland. Fische* VIII, p. 48 (1794).
[3] Gunther, A., *Cat. Fish. Brit. Mus.* V, p. 59 (1864).

extensive but are always narrow, and a large air-bladder free in the abdominal cavity (Text-fig. 2*a*). As there appears to be a considerable confusion regarding the specific limits of the two species I give below their brief history and chief taxonomic features.

Pseudeutropius atherinoides (Bloch.)

P. atherinoides was described from Tranquebar, but later Hamilton[1] described two species from Bengal—*Pimelodus urua* and *P. angius*—which have rightly been regarded as synonymous with Bloch's species. Hamilton himself pointed out the close affinity between *P. urua* and *P. atherinoides*. *P. angius*, with brilliant colour markings, is only a colour form of *P. atherinoides*. Valenciennes's[2] *Bagrus exodon* is undoubtedly the same as Day's *Pseudeutropius acutirostris*.[3] The former was



Text-fig. 3.—Ventral surface of the anterior part of head of three specimens of *Pseudeutropius atherinoides* (Bloch), showing stages in the prolongation of the upper jaw and the development of teeth.

a. Standard length of specimen 59 mm.: × 10; *b*. Standard length of specimen 64 mm.: × 8; *c*. Standard length of specimen 100 mm.: × 5¼.

[1] Hamilton, F., *Fish. Ganges*, pp. 177, 180, 377 (1822).

[2] Valenciennes, A., in *Belanger Voyage Ind. Orient. Zool.*, p. 385 (1834).

[3] Day, F., *Proc. Zool. Soc. London*, p. 618 (1869).

described from Bengal whereas the latter is stated to be common in the Irrawaddy and other large Burmese rivers. The differences in dentition and colouration noticed among individuals of this species seem to indicate sexual dimorphism but the material is insufficient for a proper elucidation of this problem. In the collection of the Indian Museum there are specimens showing various stages in the elongation of the upper jaw and in one example from the Sunderbans typical *acutirostris*-condition of the snout is present. Though the figure of *Bagrus exodon* is rather poor for the determination of the species, the description of the dentition leaves no doubt about its identity. It runs as:

"Nous lui donnons cette épithète d'*Exodon*, qui veut dire hors dents, parce qu'elle caractérise notablement les dents inter-maxillaires adhérentes à de larges plaques au bout du museau, de manière a dépasser entièrement la mâchoire inférieure."

Chaudhuri[1] described a new variety of *P. atherinoides* from young specimens with the characteristic colour bands. "A narrow spiral corrugation on chest" in the variety *walkeri* is an artifact due to the action of the preservative used. The eyes are never subcutaneous in this species, and Chaudhuri's description is inaccurate on this point also.

Pseudeutropius mitchelli Günther.

Pseudeutropius mitchelli was described by Günther[2] from two young specimens, "Three and a half inches long", collected in the Madras Presidency. Unfortunately no specific locality is mentioned. In 1865, Day[3] regarded it as a synonym of *P. sykesi* (Jerdon) and remarked:

"By no means rare in the rivers of Malabar. In two specimens the adipose fin was absent, perhaps lost by some accident; probably from some such deformed specimen Dr. Jerdon described the *Schilbe sykesii*."

In his *Fishes of Malabar*, he reaffirmed this view and stated that the species grows to above eight inches in length. Günther in the *Zoological Record* for the same year (p. 199) made the following observation under *Pseudeutropius mitchelli*:

"Although Mr. Day states (*Fish. Malabar*, p. 192) that he has no doubt Mr. Jerdon described his *Schilbe sykesii* from an example without adipose fin, it must, even in that case, appear doubtful whether the fish is identical with *P. mitchelli*. If he cannot verify his assertion by the examination of the typical specimen, he has no right to exchange the name of a well-determined species for that of a doubtful one."

Day's reply to the above is contained in a footnote on p. 423 of his *Fishes of India* where after referring to Günther's observations he remarks: "Jerdon had described the species fifteen years before Dr. Günther, and sufficiently well for my recognizing it at a locality where he found it".

Jerdon's description[4] of *Schilbe sykesii* is of a generalised nature and insufficient for the determination of the species. Jerdon's examples,

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[1] Chaudhuri, B. L., *Rec. Ind. Mus.* VII, p. 444 (1912).

[2] Gunther, A., *Cat. Fish. Brit. Mus.* V, p. 59 (1864).

[3] Day, F., *Proc. Zool. Soc. London*, p. 289 (1865).

[4] Jerdon's description of *Schilbe sykesii* (*Madras Journ. Litt. Sci.* XV, p. 335, 1849) is as follows:

"Head one-fifth of whole length of body; much compressed, its width being about half its length; eye large, being 3½ times in the head; maxillary cirri reach the ventral fin, all the other (6) cirri longer than the head; dorsal and pectoral spines serrated; the latter strongly so; anal fin about one-third of length of body—D. 1-6; A. 36—colour greenish above, silvery on the sides and beneath."

about 6 inches in length, were obtained from the Cauvery. Recently I have got a large collection of fish from the same river made by Prof. C. R. Narayan Rao. There is a specimen in this collection which I refer to Jerdon's species. A thorough examination of this specimen and its comparison with others have shown that it undoubtedly belongs to *P. sykesi* which has proved to be identical with Sykes' *Hypophthalmus taakree*[1]. Of the latter I have received a large number of fresh specimens from the Western Ghats, so there can be no doubt about its true identity.

The three specimens in the collection of the Indian Museum referred by Day to *P. sykesi* are about 5 inches in length without the caudal fin. The vomerine teeth in these specimens are in two distinct patches and the air-bladder is moderately extensive and lies free in the abdominal cavity; it also forms blister-like translucent areas above the pectoral fins. Mr. Norman very kindly examined the types of *P. mitchelli* and sent me a sketch of its upper dentition. He also observed that the " blister-like translucent area above the pectoral fin is indicated in the types of this species." The difference in the extent of the vomerine teeth of *P. mitchelli* and *P. sykesi* (Day *nec* Jerdon), as figured above, is probably due to the relative age of the specimens. I have noticed this in the case of *P. atherinoides* also; in the young the bands on the palate are more extensive and become somewhat reduced as the fish grows in size. From the above it is clear that Day was right in regarding *P. mitchelli* as identical with his *P. sykesi*, but unfortunately his *P. sykesi* is not the same as *P. sykesi* (Jerdon) which has now to be regarded as a synonym of *P. taakree* (Sykes). Thus *P. mitchelli* stands as a valid species.

Superficially *P. mitchelli* and *P. atherinoides* are very similar, but Mr. Norman informs me that the former has a smaller head, with the nape distinctly less elevated. These differences are also present in the specimens before me. In the adult specimens of *P. atherinoides* the snout is usually produced and bears teeth on the ventral surface.

Günther states that in his *P. mitchelli* the pectoral spine does not extend backwards to the vertical from the dorsal spine. This is not so in three specimens I refer to this species wherein the pectoral spine extends beyond the base of the dorsal spine.

Proeutropiichthys Hora.

1937. *Proeutropiichthys*, Hora, *Cur. Sci.* V, p. 353.

The genus *Proeuropiichthys* was proposed for such species of *Pseudeutropius*-like fishes in which the vomerine and palatine teeth form four distinct patches; these may be contiguous, slightly separated or widely apart from one another. The air-bladder is not extensive and thin-walled as in *Pseudeutropius*, but is of moderate size and lies free in the abdominal cavity.

Eutropius macrophthalmus Blyth was designated as the genotype of *Proeutropiichthys*, but an examination of fresh material from various

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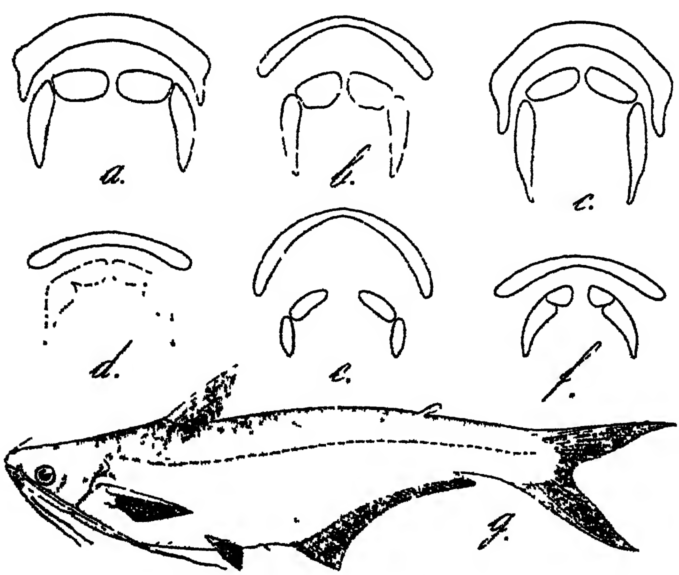
[1] Sykes, W. H., *Trans. Zool. Soc. London* II, p. 369 (1841).

localities in Peninsular India has shown that it is synonymous with *Hypophthalmus taakree* Sykes. As indicated below, this genus seems to be monotypic.

Proeutropiichthys taakree (Sykes).

1841. *Hypophthalmus taakree*, Sykes, *Trans. Zool. Soc. London* II, p. 369, pl. lxiv, fig. 4.
1849. *Schilbe Sykesii*, Jerdon, *Madras Journ. Litt. Sci.* XV, p. 335.
1849. *Bagrus taakree*, Jerdon, *ibid.*, p. 336.
1853. *Bagrus taakree*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1860. *Eutropius macrophthalmus*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 156.
1864. *Pseudeutropius megalops*, Gunther, *Cat Fish. Brit. Mus.* V, p. 60.
1864. *Pseudeutropius longimanus*, Gunther, *ibid.*, p. 60.
1867. *Eutropius taakree*, Day, *Proc. Zool. Soc. London*, p. 564.
1869. *Pseudeutropius taakree*, Day, *ibid.*, p. 617.
1877. *Pseudeutropius taakree*, Day, *Fish. India*, p. 471, pl. cix, fig. 4.
1889. *Pseudeutropius taakree*. Day, *Faun. Brit. Ind.* Fish. I. p. 138.
1890. *Pseudeutropius taakree*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 205.
1929. *Pseudeutropius taakree*, Prashad and Mukerji, *Rec. Ind. Mus.* XXXI, p. 178.

In view of the great taxonomic confusion that prevails regarding the specific limits of the various species included in the synonymy of *P. taakree*, I give below a short history of each and my reasons for making the nomenclatorial changes indicated above.



Text-fig. 4.—*Proeutropiichthys taakree* (Sykes).

a. Upper dentition of a specimen from Burma, 126 mm. in total length: × $2\frac{2}{3}$; *b.* Upper dentition of a specimen from the Godaveri River, 136 mm. in total length: × $3\frac{1}{2}$; *c.* Upper dentition of a specimen without history, 119 mm. in standard length: × 3; *d.* Upper dentition of type-specimen of *Pseudeutropius longimanus* Günther. After a sketch by Mr. J. R. Norman; *e.* Upper dentition of a specimen from Poona, 102 mm. in standard length: × $4\frac{1}{2}$; *f.* Upper dentition of type-specimen of *Pseudeutropius megalops* Günther. After a sketch by Mr. J. R. Norman; *g.* Lateral view of a specimen (No. F. 12131/1) from Poona: × $\frac{2}{3}$.

Sykes described his *Hypophthalmus taakree* from specimens collected in the " Beema river, near Pairgaon ", and characterised it as follows:

" An *Hypophthalmus*, with 8 cirri, 2 of which reach to the ventral fins; 2 very minute *cirri* near the nostrils, and 4 on the chin, nearly as long as the head; with the first dorsal and pectoral rays serrated on the posterior edges, and with 8 rays in the dorsal and 50 in the anal fin."

From a perusal of the full description and figure of the species attention may be directed to the following other salient features of the fish:

(i) " Eyes so much on the edge or side of the head as to be seen in half their diameter from below."

(ii) " Tail being bent downwards from the end of the second dorsal and anal fins."[1]

(iii) " Snout nearly on a line with the level of the back, which is very slightly raised: belly more arched than the back ".

Though as judged by modern standards, this species is insufficiently characterised, it is so common in the Deccan that there can be no doubt about its identity. I have examined large series of specimens of this species from Poona, Deolali, Hyderabad-Deccan, Godaveri, etc. There are, no doubt, marked variations in the number of rays in the anal fin and also in the development of dentition, but these are hardly of any specific value, especially when they intergrade. Being a variable species, it seems to have been described by later workers under several names.

Jerdon included this species in his list of the freshwater fishes of Southern India but gave a wrong diagnosis of the fish mentioning " Adipose fin long, anal fin short." In fact, the reverse of this was described by Sykes. *Schilbe sykesii* of Jerdon also appears to be synonymous with *P. taakree* as indicated above under *Pseudeutropius mitchelli* Günther (*vide supra*, p. 105).

Bleeker also recognised *P. taakree* as a valid species, but both Jerdon and Bleeker included it under *Bagrus*.

Blyth described *Eutropius macrophthalmus* from Tenasserim and characterised it as follows:

" Of the usual form of this genus, but with remarkably large eyes, that occupy more than half of the height of the head. Longer maxillary cirri reaching to the vent, the four inferior cirri to base of pectorals; spines slender, the pectoral less so, and all minutely pectinated behind; the dorsal also jagged in front for its basal half."

" D. 1-7.-A. 47 to 54."

" Colour bright silvery infuscated along the back, with a golden lustre on the gill covers. Soft rays of the dorsal and pectoral infuscated except at base; also the median portion of the deeply forked caudal, while several outer rays of the caudal above and below are white throughout. Ventrals and anal white; the slender adipose fin having minute dusky spots. Longest specimen 6½ in."

Günther[2] regarded this species as a doubtful form of *Pseudeutropius*, while Day[3] considered it as a synonym of *P. goongwaree*[4]. I[5] have already shown the precise specific limits of Sykes' *goongwaree* and its position in the genus *Eutropiichthys*. Though Blyth's description of

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[1] This is an artifact. I have examined a specimen from Poona in which the back is arched as described by Sykes; it is figured here as text-fig. 4*g*.

[2] Gunther, A., *Cat. Fish. Brit. Mus.* V, p. 58 (1864).

[3] Day, F., *Fish. India*, p. 471 (1877).

[4] Sykes, W. H., *Trans. Zool. Soc. London* II, p. 369 (1841).

[5] Hora, S. L., *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 435 (1937).

the species, especially on account of the absence of any reference to dentition of the fish, is insufficient for its precise determination I am convinced that this 'large-eyed *Eutropius*' could not be anything else except the form described by Day as *P. taakree* from Burma. Under *P. taakree* Day observed : "I have obtained in Burmah, as high as Mandalay, specimens which I am unable to separate from this species, except that in some the pectoral spine is slightly shorter, in other the adipose fin is almost or quite absent". I have examined specimens from Pegu and Mandalay referred by Day to *P. taakree* and also fresh specimens collected by Dr. B. N. Chopra in the Myitkyina District, Upper Burma. The latter specimens were reported upon by Prashad and Mukerji who remarked :

"The samples before us from Kamaing differ from Day's description mainly in their head being broader, the maxillary barbels shorter; the dorsal as well as the pectoral spines besides being denticulated posteriorly, are finely serrated anteriorly. Day 'obtained in Burma, as high as Mandalay', specimens apparently belonging to this species but with a shorter pectoral spine. It is quite possible that the Burmese specimens of *P. taakree* are distinct from the Indian."

The differences noted above are probably due to the large size of the Burmese examples in the collection studied by Prashad and Mukerji, for in larger specimens from Deccan the pectoral and dorsal spines are granulated along the anterior border. In smaller individuals these serations are very fine and the outer border of the spine may appear as smooth. It is quite possible, however, that the Burmese race of the species may prove to be distinct but at the present the material from Burma is not sufficient to make such a detailed study.

Though Günther[1] doubtfully referred *Hypophthalmus taakree* Sykes to *Eutropius*, he described two species under *Pseudeutropius*, *P. megalops* and *P. longimanus*, which appear to be synonymous with Sykes' species. *P. megalops* was described from a single specimen "Six inches long. Godaveri at Mahadespur. Orissa. From the Collection of Messrs. V. Schlagintweit." Day[2] included this species, with a query, under the synonymy of *P. murius*, and no other author appears to have commented on the specific limits of this species. In order to verify Day's contention I sent a sketch of the dentition of '*P. murius*' (I[3] have included *murius* in the genus *Eutropiichthys*.) to Mr. J. R. Norman of the British Museum and requested him to compare it with the dentition of the type-specimen of *P. megalops*. He informed me that "The type of this species [*P. megalops*] has a dentition quite different to that shown in your sketch, so that I have given a rough sketch of this (Text-fig. 4 *f*). A second specimen in the British Museum identified as *P. megalops* (120 mm.) has a dentition agreeing exactly with your sketch." On further enquiry I learnt that the second specimen of *P. megalops* came from North East Bengal and formed part of the collection made by Jerdon.

The above information definitely clears up two points: (i) that *P. megalops* and '*P. murius*' are two distinct species and (ii) that Day may have been misled in his conclusion on account of the wrong identification of Jerdon's specimen in the British Museum.

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[1] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 52 (1864).
[2] Day, F., *Fish. India*, p. 472 (1877).
[3] Hora, S. L., *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 435 (1937).

To bring out the differences between *P. megalops* and "*P. murius*" I requested Mr. Norman to compare the two specimens of *P. megalops* in the British Museum. He very kindly sent me the following note on this point.

"With regard to the two specimens of *Pseudeutropius megalops* of which the dentition is different these are certainly not of the same species and there is little doubt that Jerdon's specimen has been incorrectly named. In the type of *P. megalops* the depth of the body is $5\frac{1}{4}$ in the length without the caudal fin and the head 5, whereas in Jerdon's specimen the depth is 4 and the head $4\frac{3}{4}$. Further the maxillary barbel extends beyond the origin of the anal fin in the type and the caudal peduncle is longer than deep, whereas in Jerdon's specimen the barbel only reaches the first quarter of the pectoral spine and the caudal peduncle is about as deep as long. There are other minor differences but these are the more important."

In the collection of the Zoological Survey of India, there are 4 specimens from the Godaveri River collected by Dr. N. Annandale at Rajahmundry which agree fairly closely with Günther's description of *P. megalops*, especially in the form of the dentition (Text-fig. 4 *b*). The proportions, length of barbels, etc. differ to a certain extent, but these differences cannot be regarded as specific. The number of anal rays varies from 42 to 49. I give below a table of measurements of these examples, which seem to me to belong to *P. taakree*.

Measurements in millimetres.

Standard length	108·5	103·0	65·0	55·0
Length of head	24·0	21·5	14·5	11·8
Width of head	13·5	12·0	7·8	6·0
Height of head at occiput	15·5	14·5	10·0	8·5
Length of mouth	5·0	4·0	3·0	2·5
Width of mouth	6·4	5·5	4·1	3·3
Diameter of eye	7·0	7·0	6·0	5·1
Length of snout	8·0	8·0	4·9	4·0
Interorbital width	7·5	7·2	4·5	4·0
Width of body	11·0	11·0	7·0	5·0
Height of body	20·0	18·0	12·5	9·0
Length of pectoral spine	20·4	19·0	11·0	D.
Length of dorsal spine	17·5	16·0	8·8	7·0
Length of nasal barbel[1]	10·5	10·0	7·0	4·5
Length of maxillary barbel[2]	50·0	46·5	29·0	25·2
Length of outer mandibular barbel	25·0	24·0	12·0	10·0
Length of inner mandibular barbel	25·5	25·4	13·0	12·0
Length of caudal peduncle	16·0	14·0	7·5	6·5
Least height of caudal peduncle	9·0	8·5	5·0	4·0
Commencement of dorsal from tip of snout	34·0	31·5	20·5	16·5

P. longimanus was described from a "Skin: 6 inches long: not good state. India. From the Collection of the Zoological Society." The main difference from *P. megalops* seems to consist in the number of rays in the dorsal and anal fins (D. 1/6; A. 41 for *P. megalops* and D. 1/8; A. *ca* 54 for *P. longimanus*). I have referred above to the variation in the number of anal rays of *P. taakree* and after having examined large series of specimens it is not possible for me to recognise

[1] Reaching to the middle of the eye-diameter.
[2] The length of maxillary barbels is very variable; usually they extend to the end of the pelvic fins but they may be shorter or longer.

the above differences as of any specific value. Accordingly, I agree with Day[1] that *P. longimanus* is synonymous with *P. taakree.* Day[2] was of the opinion that the type-specimen of *P. longimanus* was from the collection of Col Sykes and may have been the original of his *P. taakree.*

At my request, Mr. J. R. Norman sent to me a sketch of the dentition of *P. longimanus* (Text-fig. 4 *d*) and it also shows that the species is identical with *P. taakree.* There are two old, poorly preserved specimens in the Indian Museum (Cat. No. 509) without any locality label or name of donor in which the number of fin-rays and dentition (Text-fig. 4 *c*) correspond with Gunther's description of *P. longimanus.*

As noted in the case of several other Indian species, the distribution of *P. taakree* is also of zoogeographical interest; it is found in Deccan on the one hand and Burma on the other, and has not yet been recorded from the intermediate regions. There is one lot of 6 old specimens in the collection of the Indian Museum (No. Cat. 507) which is labelled to have been collected at Calcutta. This record seems to be rather doubtful.

Ailia Gray.

The generic name *Ailia* was proposed by Gray as a subgenus of *Malapterus* (*sic*) to accommodate his species '*Malapterus* (*Ailia*) *Bengalensis*' figured in the *Illustrations of Indian Zoology.* This figure is a copy of Hamilton's original drawing of *Malapterurus coila.* The definition of the genus is, however, given in the *Zoological Miscellany* (p. 8, 1831) and is as follows:

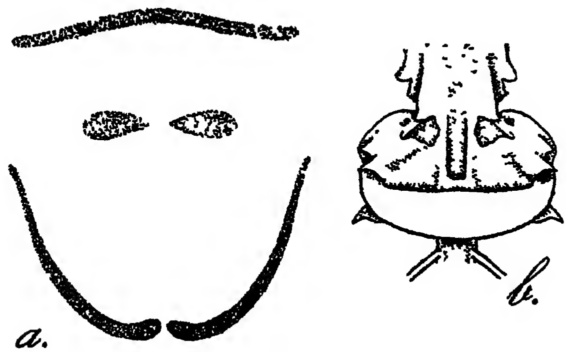
"Body compressed; fins all spineless; fat fin very short and small over the end of the very long anal fin; ventral fins all nearly under the pectoral; tail forked. Most allied to *Malapterus* of Geoffroy."

At the same time Gray described the genus *Acanthonotus* for *A. hardwickii* which is also figured in the *Illustrations.* Both the figure and the description appear to be based on a badly preserved specimen of *Ailia coila* (Ham.) in which the neural spines projected beyond the dorsal profile giving the false appearance of "a series of small spines" before the spineless dorsal. Though the latter generic name has line priority over *Ailia,* it is not accepted here owing to its diagnosis being very defective.

The genus *Ailia* is remarkable in several respects and Bleeker[3] constituted a separate group Ailianini in the sub-family Ailichthyoidei for its reception. Günther[4], however, included it in his composite group Silurina, but Regan[5] in his classification of the Siluroid fishes accommodated it in a separate subfamily—Ailiinae—of the Schilbeidae. The most salient features of *Ailia* are: (i) tubular, horse-shoe-shaped air-bladder, (ii) absence of rayed dorsal; (iii) presence of a small adipose dorsal, (iv) long anal fin; (v) eight well-developed barbels; (vi) forked caudal and (vii) fairly well marked dentition. Of these, great import-

[1] Day, F., *Proc. Zool. Soc. London,* p. 617 (1869).
[2] Day, F., *Fish. India.* pp. iv (under Sykes), 471 (1877).
[3] Bleeker, P., *Ichth. Arch. Ind. Prodr.* 1, Siluri, pp. ix, 248 (1858).
[4] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 55 (1864).
[5] Regan, C. T., *Ann. Mag. Nat. Hist.* (8) VIII, p. 567 (1911).

ance has been attached to the structure of the air-bladder which has been described by Day[1], Bridge and Haddon[2] and Nair[3].



Text-fig. 5.—Dentition and air-bladder of *Ailia coila* (Hamilton) *a*. Dentition: × 8; *b*. Air-bladder: × 5.

In 1871, Day (*loc. cit.*) established the genus *Ailiichthys* for *A. punctata* found in " The Jumna, and southern rivers in the Punjab that are tributaries of the Indus, but not those on the hills, " and characterised it as: " Differing from *Ailia* in that the ventral fins are entirely absent." In several cases I have previously referred to the absence of pelvic fins in fishes and shown that no reliance can be placed on this character for taxonomic purposes. In *Ailia*, for instance, the body is greatly compressed and almost leaf-like. The pelvic fins are very small and lie below the pectorals. In these circumstances their function is taken over by the pectorals, which are somewhat more elongated than usual, and in consequence the pelvics may be regarded as mere vestigeal organs. It is no wonder, therefore, if under certain circumstances they do not make their appearance altogether. Similar cases of abnormality have been observed by a number of workers. Günther[4] explained the absence of pelvics on the assumption that " The chief function of these fins is to balance the body of the fish whilst swimming; and it is evident that, in fishes moving during a great part of their life over swampy ground, or through more or less consistent mud, this function of the ventral fins ceases, and that nature can readily dispense with these organs altogether." This is probably true in the case of such genera as *Channallabes*, *Apua*, *Channa*, etc. which live in mud or vegetable débris, but *Ailia* is certainly not a bottom fish as is evident from its form and colouration. In the case of *Ailia* it seems probable that owing to the extension of the tail region and the compression of the head and body there remains very little space for the attachment of the pelvic fins. Moreover, the elongation of the pectorals as far back as the anal fin rendered the presence of pelvics as useless. In the economy of nature,

[1] Day, F., *Proc. Zool. Soc. London*, p. 712 (1871).
[2] Bridge, T. W. and Haddon, A. C., *Phil. Trans. Roy. Soc. London* (B) CLXXXIX, p. 208 (1894).
[3] Nair, K. K., *Rec. Ind. Mus.* XL, pp. 185, 186 (1938).
[4] Günther, A., *Ann. Mag. Nat. Hist.* (4) XII, p. 143 (1873).

therefore, these organs may sometime be totally absent. In view of what is stated above, I do not consider *Ailiichthys* as a separate genus from *Ailia*. In fact, my examination of the material in the collection of the Indian Museum shows that *Ailiichthys punctatus* Day is synonymous with *Ailia coila* (Ham.). Thus I am able to recognise only one species in this geneus.

XII. A Further Note on Fishes of the Genus *Clarias* Gronovius.

In 1936, I[1] discussed the systematic position of the various forms of *Clarias* described from India, Burma and Ceylon, and concluded that only three species can be recognised from these regions, *viz.*, *C. batrachus* (Linn.) (Ceylon, India, Burma, the Malay Archipelago and further east), *C. brachysoma* Günther (Ceylon) and *C. dayi* Hora (Wynaad Hills). Since then I have examined the Siluroid material preserved in the collections of the Bombay Natural History Society and the Government Museum, Madras, and among them found specimens (2 from Karkala, South Canara District and 7 from Goa), which, though closely allied to *C. brachysoma*, differ in certain respects from all the three species enumerated above. A similar specimen was also found in a collection of fishes sent by Prof. P. W. Gideon for determination; it was collected in a *nullah* near Belgaum. A close study of these specimens and literature has shown that they are referable to *C. dussumieri* Cuv. & Val.,[2] which was described from Malabar and Pondicherry from specimens 7 to 8 inches in length, and distinguished from *C. batrachus* (=*C. magur*) by the following characters:—

"avec la tête lisse et large de la deuxième [*C. magur*], a les épines pectorales plus sensiblement dentées, et les dents de l'arc vomérien approachent plus de la forme de petits pavés que de celle de dents en velours ras."

Though *C. dussumieri* was found by Jerdon[3] "in tanks and ditches in Malabar", Günther[4] regarded it only as a *species inquirendum*. At the time of writing 'The Fishes of Malabar', Day[5] had not examined any specimen of the species but later he[6] found one example, 7 inches long, from the Wynaad which he assigned to *C. dussumieri*. This specimen, which is now preserved in the collection of the Indian Museum and is in a very poor state of preservation, was found by me (*loc. cit.*) to be abundantly distinct from all the known species of the genus and was accordingly made the type of a new species *C. dayi* Hora. In my previous note I regarded *C. dussumieri* as a synonym of the widely distributed Indian species, *C. batrachus*, but fresh material from the Malabar zone has convinced me that it is worthy of recognition as a distinct species. It is distinguished from *C. batrachus*, among other characters, by its greater distance between the occipital process and

[1] Hora, S. L., *Rec. Ind. Mus.* XXXVIII, pp. 347-351, text-figs. 1-5 (1936).
[2] Cuvier, G., and Valenciennes, A., *Hist. Nat. Poiss.* XV, p. 582 (1840).
[3] Jerdon, T. C., *Madras Journ. Litt. & Sci.* XVI, p. 342 (1849).
[4] Günther, A., *Cat. Fish. Brit. Mus.* V, p. 17 (1864).
[5] Day, F., *Fishes of Malabar*, p. 197 (1865).
[6] Day, F., *Fish. India*, p. 484 (1877).

commencement of the dorsal fin; from *C. brachysoma* in having a more coarsely serrated pectoral spine, somewhat shorter barbels and more obtuse teeth on the palate and from *C. dayi* in having much longer nasal brabels, less molariform teeth and less strongly serrated pectoral spine. It is thus in several respects an intermediate form between *C. brachysoma* and *C. dayi*.

Specimens of *C. brachysoma* from Ceylon have usually been referred to *C. teysmanni* Bleeker (Java, Sumatra, Borneo and Malacca), but after an examination of the type material of both the species in the collection of the British Museum of Natural History, Mr. J. R. Norman (*vide* Hora, *loc. cit.*, p. 349) showed that the two forms are distinct. Generally speaking, there is no doubt regarding the very close similarity between the species typical of the Malabar zone and Ceylon on the one hand and of the Malay Archipelago on the other. Attention may here be directed to an error in my previous article on *Clarias* in the explanation of text-figure 2, *viz.*, text-figure 2*a* represents, after Norman, the vomerine tooth band of *C. brachysoma* and text-figure 2*b* that of *C. teysmanni* and not *vice versä* as was then described.

For facility of reference in future I give below full descriptions of *C. dussumieri* Cuv. & Val. For a detailed account of *C. dayi* Hora reference may be made to Day's descriptions of *C. dussumieri* both in the *Fishes of India* and in the *Fauna*.

Clarias dussumieri Cuvier and Valenciennes.

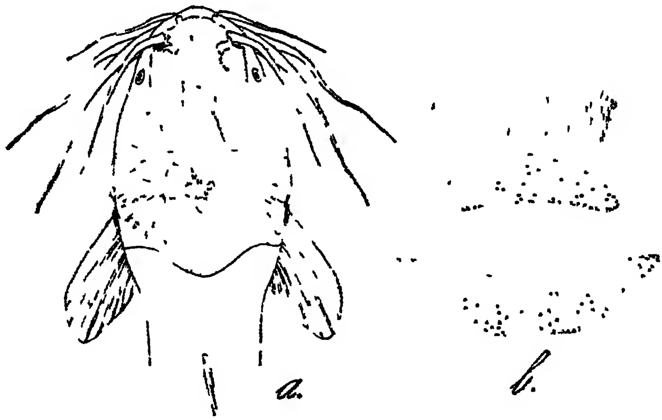
1840. *Clarias Dussumieri*, Cuvier and Valenciennes. *Hist. Nat. Poiss.* XV. p. 382

D. 66-69; A. 45-59: P. 1/10-11; V. 6.

Clarias dussumieri is an elongated fish in which the depth of the body is contained from 8·4 to 9·4 times, the length of head to end of gill-cover 6 times and to end of occipital process 4·5 times in the total length. The height of head is contained from 1·5 to 1·7 times in its length. The head is almost as broad as long. The diameter of the eye is contained from 8 to 10 times, the length of snout from 2·7 to 3·2 times and the interorbital width 1·8 times in the length of the head. The occipital process is broadly rounded: its height is considerably less than half the length of its base. The distance between the origin of dorsal and occipital process is contained about 3 times in the length of the head to the end of the occipital process.

The dorsal surface of the head is roughened with ridges. The frontal fontanel is almost twice as long as broad and extends as far as the front border of the eye, while the occipital fontanel is oval and much shorter. The interorbital distance is greater than the width of the mouth and is almost equal to the postorbital part of the head. The nasal barbels extend as far as the occipital fontanel; the maxillary barbels extend beyond the bases of the pectorals; the outer mandibulars reach the bases of the pectorals while the inner mandibulars are shorter. There are villiform teeth in the jaws; those in the upper jaw are in the

form of a continuous band one-fifth as broad as long; those in the lower jaw are grouped in two contiguous patches which are produced back-



Text-fig. 6.—*Clarias dussumieri* Cuvier and Valenciennes.

a. Dorsal surface of head and anterior part of body up to commencement of dorsal fin: × ¾; *b*. Dentition: × 2½.

wards at the sides. The vomerine teeth are conspicuously obtuse and are situated in a broad crescentic band.

The dorsal fin commences almost above the termination of the pectorals and is separated from the caudal by a distinct notch. The caudal fin is longer than the head and is roundly pointed at the end; it is not confluent with the anal and the dorsal fins. The pectoral fin is considerably shorter than the head; its spine is strong and conspicuously serrated along the outer border; along the inner border it is provided with a few small teeth in the middle. The pelvic fins extend beyond the commencement of the anal fin.

In the preserved specimens there are no distinct markings; the general colour is somewhat darker above and lighter below.

Variations.—The above description is based on two fine examples from Karkala in South Canara District. The seven specimens from Goa are in a poor state of preservation but generally agree in almost all particulars with the Karkala examples. The specimen from Belgaum is, however, stumpy and stout with the body considerably deeper, head somewhat broader and the paired fins shorter. The pectoral spine is relatively much shorter.

Distribution.—Along the Malabar Coast generally; it has been recorded from Pondicherry, Goa, South Canara and Belgaum.

Remarks.—Except for the differences in the nature of the pectoral spine and vomerine teeth, and the length of barbels *C. dussumieri* is closely related to *C. brachysoma* of Ceylon and *C. dayi* of the Wynaad. In the following Table I give measurements of 3 specimens of *C. dussumieri* and of 3 specimens of *C. brachysoma* for purposes of comparison.

Measurements in millimeters.

	C. dussumieri Karkala.		*C. dussumieri* Belgaum.	*C. brachysoma* Ceylon.		
Total length	253·0	227·0	178·8[1]	232·2[2]	236·0	206·0
Length of caudal	34·0	33·0	22·5	33·0	34·0	28·2
Depth of body	30·0	24·0	26·0	35·0	29·2	30·5
Length of head to end of opercle	41·2	38·0	34·2	44·0	40·0	33·0
Length of head to end of occipital process	54·3	49·6	43·4	54·2	50·5	44·5
Height of head	27·8	22·0	22·3	29·8	25·2	25·0
Width of head . .	38·0	34·5	33·0	39·5	37·5	31·8
Length of snout	14·3	13·8	10·5	15·2	14·0	10·5
Diameter of eye .. .	5·0	3·9	3·0	4·2	4·2	3·5
Interorbital width	22·6	21·0	19·0	24·0	23·2	19·0
Length of pectoral spine ..	22·0	18·2	13·8	19·5	19·0	15·2
Length of pectoral	30·2	25·6	20·7	28·6	28·0	21·8
Length of pelvic	19·8	18·8	14·0	17·8	15·6	15·0
Length of nasal barbel ..	32·0	31·0	25·0	35·6	36·2	28·5
Distance between occipital process and dorsal fin	17·4	16·3	14·7	20·5	18·0	16·4

[1] The caudal fin is partly damaged in this specimen.
[2] This is a mature female full of eggs.

LARVAL DEVELOPMENT OF *GARRA CEYLONENSIS CEYLONENSIS* (BLEEKER).

By S. JONES. *M.Sc., Central Research Institute, University of Travancore, Trivandrum.*

In a previous paper (Jones, 1938*a*) the external features in the embryonic development of *Garra ceylonensis ceylonensis* (Bleeker) were given, and the present paper deals with the post-embryonic development of this form till the attainment of adult features. A week after the specimens hatched out, they were brought down from Demodera (Ceylon) to Colombo, and from there to Tambaram, Madras. It is of interest to note that the larvae stood the journey well and readily adapted themselves to a very hot climate from a comparatively mild one, and to Tambaram water which is well known for the high percentage of dissolved calcium salts.

Newly hatched larva.—It is 5 mm. in length and usually remains attached to algae by the lower side of the mouth, though how this is done is not understood, as no adhesive organ of any kind was noticed. Due to the presence of functional pectoral fins the larva has greater control over its movements than other newly hatched Cyprinids. When disturbed it darts off at great speed, but hangs on to the algae after some time (for further details see Jones, 1938*a*).

Second day.—The mouth opening is larger, yolk is reduced to half and the notochord at the caudal end is bent slightly upwards (Text-fig. 1*a*). A rudiment of the air-bladder is visible. The larva has a golden yellow colour under the microscope and actively swims about in water.

Third day.—The eyes begin to shine, the air-bladder shows a distinct bubble of air, gall bladder becomes visible, small papillary projections appear on the sides of the head, chromatophores increase on the dorsal side and the animal moves about very actively.

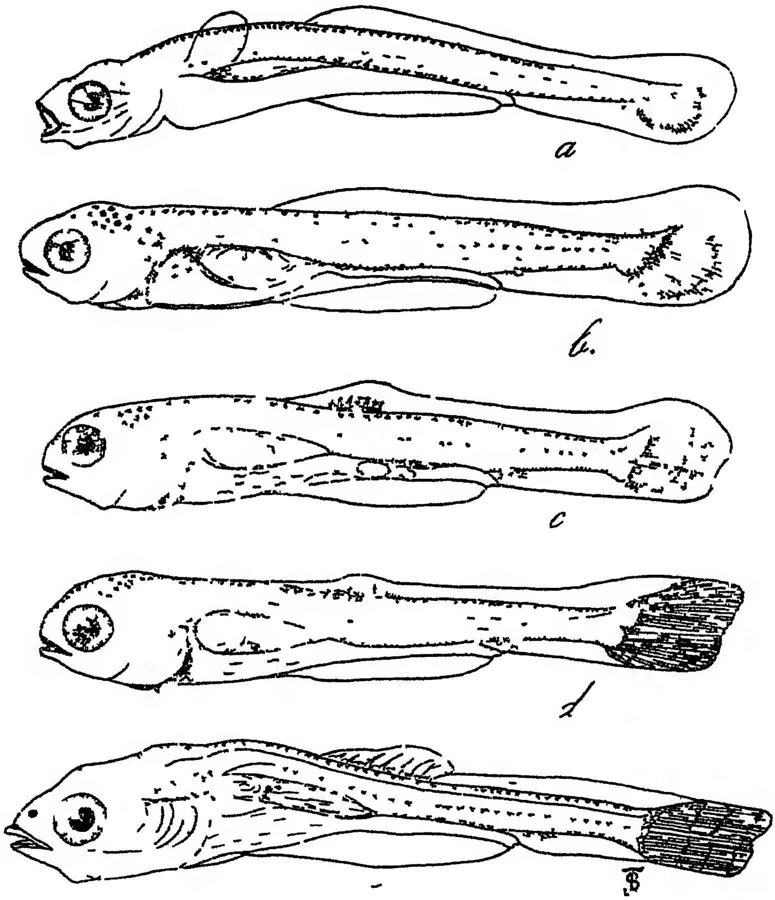
Fifth day. (Text-fig. 1*b*).—The mouth has well developed lips. All the yolk is absorbed, and the liver and the gut as a straight tube can be distinguished. External gills, which are mere filamentous elongations of the internal gill lamellae, are very well developed. The notochord at the posterior end is turned distinctly upwards and the caudal fin has rudimentary fin-rays. Chromatophores appear on the fins and the median fin-fold is broader at the position of the future dorsal fin. The papillary outgrowths on the head increase in number.

Seventh day. (Text-fig. 1c).—The chromatophores become more dense. About 18 fin-rays are formed in the caudal fin which develops a notch in the middle transforming it into the homocercal type, and rudiments of the dorsal fin-rays are developed. The animal feeds on algae.

Eighth day.—The air-bladder, which was simple at first, becomes constricted in the middle.

Ninth day. (Text-fig 1*d*).—The constriction in the air bladder becomes deeper showing two distinct regions, a rounded anterior and a conical posterior region.

Fourteenth day.—The caudal fin has a fringed edge and is well supplied with blood vessels. Minute wart-like projections, perhaps the rudiments of rostral tubercles, are found on the snout.

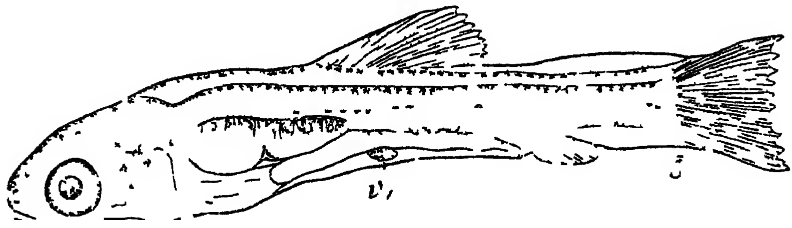


TEXT-FIG. 1.—Larval stages of *Garra ceylonensis ceylonensis* (Bleeker).
a Second day, × 20, *b* Fifth day, × 20, *c* Seventh day, × 20, *d* Ninth day, × 20, *e* Twentieth day, × 14.

Twentieth day. (Text-fig 1*e*).—Length 7·5 mm. There are seven or eight fin-rays in the dorsal fin and the caudal fin is almost homocercal, but the dorsal half is a little larger. The position of the anal fin is marked by a broader portion in the marginal fin behind the anus. The number of chromatophores have considerably increased in the body, and the animal appears light grey to the naked eye. The mouth is inferior in position. The animals display cannibalistic tendencies, the larger and stronger ones attacking and devouring the smaller and the weaker.

One month old. (Text-fig 2).—Length 8·8 mm. The anal fin with distinct fin-rays is developed though the fin-fold connecting it to the

caudal still persists and the ventrals are seen as small buds in front of the anus. The gut develops a loop in the middle and the barbels



TEXT-FIG. 2.—One month old larval stage of *Garra ceylonensis ceylonensis* (Bleeker) × ca 11.

become visible. The young fish devour everything from bread and rice to frog meat and mussel flesh, and browse on the algal growth on the sides of the aquarium.

One and a half months old.—The young fish is 13·3 mm. long and has attained most of the external characters of the adult except the ventral sucker which is only rudimentary. The mouth is antero-ventral in position. There is only a single surviving specimen which grows stout with the ventral side getting flattened.

When the fish is about 2 months old the mouth becomes ventral in position and the sucker is developed. It is omnivorous in its diet, greatly relishing chopped meat and flesh. Since the development of the sucker the animal continually feeds on the algae growing on the sides of the aquarium.

The author's idea of working out the development of the ventral sucker had to be given up owing to the lack of specimens belonging to the later stages. About 40 living specimens were brought from Ceylon, and of these only two survived after a month and a half. One of them grew to a length of one and a half inches when three months old. In November 1937, the author had to leave Tambaram for Trivandrum and the specimen was also taken there where it was living till the end of February 1938 when it died in the absence of the author from the place. After it was brought to Trivandrum it could not be properly attended to and it did not grow to any appreciable extent. It was a chubby little fish resembling very much its congener, *Garra ceylonensis phillipsi* Deraniyagala.

The influence of the environment on eggs is well illustrated in *Garra*, which in the course of evolution has developed a comparatively large-sized egg resulting in the precocious development of the early larva. A comparison with the eggs and early larvae of other Cyprinids, whose development is known, is of interest (Khan, 1926 and Jones 1938). Recently the author has been able to work out the development of two other South Indian Cyprinids[1] which provides additional evidence concerning the highly evolved nature of the egg and early larva of *Garra*.

The young *Garra* that was being reared used to come near the surface,

[1] The results have not yet been published.

especially in the evenings, and produce bubbles of air which accumulated as patches of sticky foam near the sides of the aquarium. Fraser (1937, p. 705) has recorded this habit in a number of Cyprinid fishes of Deolali, Nasik. As Hora says in a footnote (Fraser, *op. cit.*), the sticky nature of the bubbles may be caused by the slime taken up by the air as it passes over the gills.

About *Garra mullya* which was able to live for a short period of four days only in the aquarium, showing all the time respiratory difficulties due to lack of oxygen Fraser (*op. cit.*, p. 691) says, " They periodically and frequently rose to the surface and by muscular action alone maintained themselves perpendicularly suspended, but not by their lips, for 30 to 35 seconds. While thus engaged, they create a froth of bubbles ". Mr. S. J. Silas of Demodera (Ceylon) had a small fish-pond and I was able to notice adult specimens of *Garra* showing a similar behaviour whenever they were introduced into it. None of the specimens survived for more than a couple of days except a juvenile specimen about 4 inches long that lived for some months.

During a visit to the Peerumedu Hills in Travancore in February 1938, the author caught a young *Garra* from one of the hill streams there at a height of about 3,500 ft. This was brought to Trivandrum where it lived in a small glass vessel for 4½ months. This had the habit of making bubbles of froth regularly in the evenings.

The few experiments that I performed to test the adhesive capacity of the mental disc of an adult *Garra* were too crude and unsatisfactory to be relied on. The young specimen that the author was rearing did not at any stage exhibit any tendency to use the ventral disc as an adhesive organ. Whenever an artificial current was produced, it either swiftly darted against it or was helplessly carried along with it.

The condition was different in the case of the young *Garra* from Travancore. Whenever an artificial current was produced, it fixed itself to the bottom by the paired fins, especially the pectorals, and lowered its head bringing the ventral side into close contact with the bottom preventing the flow of water through the underside of the head. The animal remained in this position at one place for only a moment. It quickly darted forwards and effected fresh attachments. In still water it was noticed on a few occasions attempting to stick to the sides of the aquarium: but it was never found capable of effecting a permanent grip.

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LIFE-HISTORY AND BIONOMICS OF THE SPINY EEL, *MASTACEMBELUS PANCALUS* (HAMILTON), WITH NOTES ON THE SYSTEMATICS OF THE MASTACEMBELIDAE.

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(From the Laboratories of the Zoological Survey of India, Calcutta.)

CONTENTS.

INTRODUCTION.

In the course of field studies on larvicidal fishes at Ulubaria, in the Howrah District, the author found numerous specimens of *Mastacembelus pancalus* (Hamilton), both adult and young, thriving in the large borrow pit extending between Telegraph-posts 19/6 and 19/10 down, between Ulubaria and Fuleshwar. Examination of the gut-contents of the fish showed that in the young stages the species sometimes consumes mosquito larvae and cyclops besides other aquatic micro-organisms. The presence of young fish naturally suggested the possibility of the species breeding in the borrow pit. Hence a search was made for the eggs of the species with a view to study its life-history, which would be of interest, for the development of no member of the Mastacembelidae, which is a family of uncertain relationships, is as yet known. After several weeks of unsuccessful attempts, eggs were discovered on the 12th of July, 1940; these consisted of 21 eggs forming a more or less loose mass entangled in a thick mesh of the submerged portion of a floating tuft of algae consisting mainly of *Spirogyra*. The eggs, with portions of the associated algae were carefully removed to the Malaria Inspector's Laboratory near-by, and the development followed in the water from the same borrow pit in conditions similar to those described for *Aplocheilus panchax* (*vide* Job, 1940, p. 57). Subsequently on several

occasions eggs in smaller numbers were found similarly attached up to the month of November. Larvae and post-larvae of different stages were also collected and examined for comparison with identical stages among those that lived in the laboratory. The bionomics of the species was studied both in an aquarium and in the natural habitat. In connection with the relationships of the Mastacembelidae the collection of Percomorphi in the Zoological Survey of India was examined.

ACKNOWLEDGMENTS.

I am very grateful to Dr. Baini Prashad, Director, Zoological Survey of India, for various facilities afforded to me in conducting this study and for his helpful criticism. The work was done under the kind direction of Rai Bahadur Dr. S. L. Hora, and my heartfelt thanks are due to him for constant guidance and encouragement. I am also thankful to Dr. Albert W. C. T. Herre of the Stanford University, California, for his instructive discussions on the systematics of the Mastacembelidae. I am indebted to Mr. A. Duncan, Agent and General Manager, and Mr. R. Senior-White, Malariologist, Bengal Nagpur Railway, for the travelling and field facilities very kindly afforded to me. To the Lady Tata Memorial Trust I am thankful for the award of a scholarship, which enabled me to make this study along with other researches on larvicidal fishes.

LIFE-HISTORY OF THE SPINY EEL.

General.—Mastacembelus pancalus, popularly known as the Spiny Eel, is distinguished by its compressed, eel-like shape; elongated, non-protractile snout; upper jaw terminating in a moveable appendage with a trilobed tip; long, spiny dorsal and anal fins; distinct, rounded caudal fin; absence of ventrals; and characteristic colouration. It is olive green along the back, lighter olivaceous on the sides, grading into yellowish white ventrally, with numerous irregularly scattered greyish white spots over the sides and small dark grey transverse blotches scattered along the mid-dorsal surface and extending downwards as irregularly vertical stripes along the sides; there are a few dark spots and blotches over the operculum and snout with a conspicuous dark grey band on either side from the tip of the snout to the eye and behind it over the opercle. The cheeks are golden and the nostrils bluish. The fins have a greenish yellow ground colour with many dark spots and blotches, the latter being comparatively more conspicuous in the median fins. Usually the colouration is brighter in the young. It becomes duller with age, and the vertical stripes often fade, except in the posterior third or so.

Day (1889, p. 334) has recorded the species from the large rivers of India, but says that he has not seen it along the Coromandel Coast south of the Kistna. Sundara Raj (1916, p. 290), however, has observed the fish thriving in tanks all over Madras and in the Cooum. Its local names are *Pangkal, Gochi, Gaugr-Gongli,* Bengali; *Tu-rah,* Assamese; *Turi, Bahru,* Ooriah; *Chen-du-la, Gurchee, Gro-age,* Punjabi; *Ju-gar,* pashtu; *Bamni,* Urdu; *Par-pa-ral,* Telugu; and *Pil Aral,* Tamil.

Breeding.—Young specimens of *Mastacembelus pancalus* measuring about 30 mm. were found in the Spur Tank,[1] Madras, in the month of February by Sundara Raj (*op. cit.*, p. 290), and he surmised that the species "breeds during the cold weather". D'Abreu (1925, p. 30), obtained 28 mm. fry from the Ambajheri Tank at Nagpur in April, while Prashad and Mukerji (1930, p. 16) found 50 mm. specimens in the Manchar Lake, Sind, in November. In the Railway borrow pits at Ulubaria the fish breeds from May to November[2], with the peak period at the commencement of the monsoon.

The mature female of *M. pancalus* is, as a rule, stouter, but less brightly coloured than the male. The ovaries are paired, elongated, strap-shaped sacs, of which the right one is slightly longer than the left. They hold an enormous number of ova in various stages of growth. The ovaries unite posteriorly into a short common oviduct which leads out through a slit-like opening situated on an elevated urinogenital papilla behind the anus, just in front of the anal fin.

The fish builds no true nest; but at spawning time it selects a sheltered portion of some algal mass below the surface, where proper aeration and sunshine would be ensured. There it lays a varying number of eggs, usually ten to twenty at a time, which are fertilised by the male as they are being laid. The eggs are demersal, and left to themselves would sink to the bottom. But being laid on algal meshes they remain suspended on them (text-fig. 1*a*), though on shaking violently, the eggs get detached and drop to the bottom. No parent was ever seen to guard the eggs.

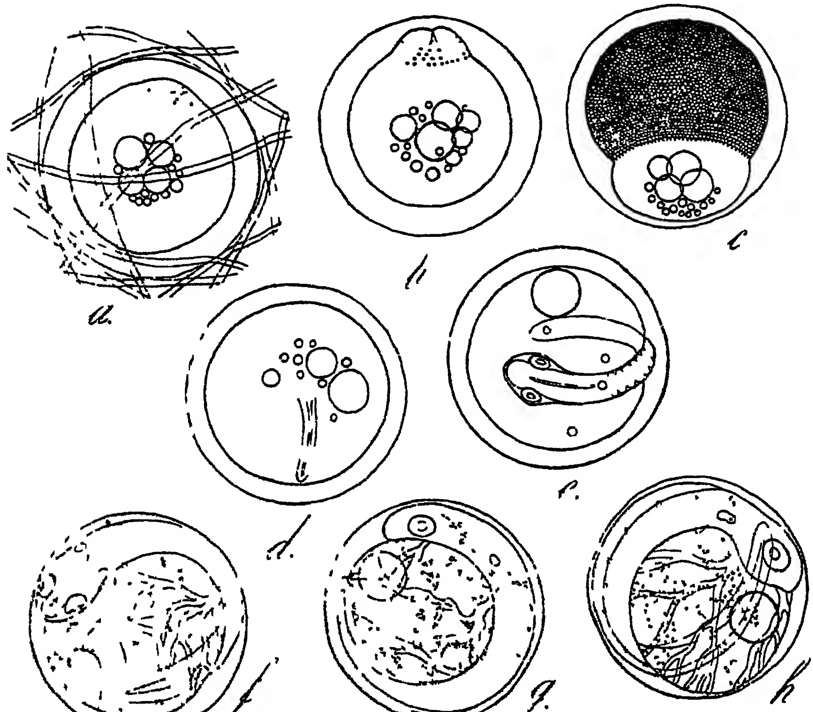
Egg and Embryonic Development.—The newly laid egg is more or less spherical and transparent; its diameter varies from 1·3 mm. to 1·35 mm. It is highly yolk-laden, and in general appearance resembles the egg of *Aplocheilus panchax* (Job, 1940, p. 57-59); but the cluster of adhesive threads so conspicuous in the egg of *A. panchax* is absent here. The egg membrane, however, bears certain irregular striations, which probably contribute towards making the egg stick to the algal tuft by friction. As in the case of *A. panchax* the egg is heavy, though provided with cospicuous oil globules of varying number and size in the yolk. The protoplasm in the fertilised egg stands out as a convex granular blastodisc. The early stages of cleavage (text-fig. 1*b*) and embryonic development are typically teleostean. It is, however, noteworthy that despite the presence of a large amount of yolk, the embryonic development is short, the eggs usually hatching a day and a half after they are laid. Text-fig. 1*c* shows an egg six hours after fertilisation. The blastoderm has spread over more than two-thirds of the transparent yolk, the uncovered portion of which remains protruding out as it were beyond the blastoderm rim, and encloses four large and several small oil globules.

[1] The Spur Tank has since been reclaimed.

[2] Eggs of the species were collected for the first time in July; but the presence of 18 mm. fry noticed in the month of June showed that breeding had commenced in May.

Nine hours old egg.

In a nine hours old egg (text-fig. 1*d*) the embryo has begun to be differentiated. The number of the oil globules is reduced, but one of them increases in size.



TEXT-FIG. 1.—*Mastacembelus pancalus* (Hamilton), segmentation of the egg and embryonic development: × *ca.* 22.

a. Unsegmented egg; *b.* Two-celled stage; *c.* About six hours after fertilisation; *d.* Nine hours after fertilisation; *e.* Twelve hours after fertilisation; *f.* Twenty-four hours after fertilisation; *g.* Thirty hours after fertilisation; *h.* Thirty-five hours after fertilisation.

Half a day old egg.

In another three hours the embryo (text-fig. 1*e*) is well differentiated with clearly marked optic vesicles. The yolk contains a single large oil globule and four to six tiny ones. The embryo is not yet free, but remains partly embedded in the yolk.

A day old egg.

In the course of the next twelve hours the embryo (text-fig. 1*f*) grows larger at the expense of a portion of the yolk. Circulation is established; chromatophores appear on the yolk and on the embryo, the chief pigment patches being a pair of irregular, elongated bands behind the eyes. The single large oil globule is conspicuous, while a few tiny ones are scattered about in the yolk. The auditory vesicles have appeared.

A day and a quarter old egg.

In a thirty hours old egg (text-fig. 1*g*) the pectoral fin buds begin to appear; the embryo grows larger, pigmentation increases, and the

median fin-fold makes its appearance. The hind region of the embryo gets freed from the yolk-sac, and at intervals the embryo twists and turns along with the yolk. The otoliths are quite clear. The circulation is active: the heart beats about 160 times per minute. The chromatophores on the yolk form conspicuous patches. The body also is more pigmented. The pigment bands behind the eyes converge posteriorly towards the mid-dorsal side. The large oil globule remains while the others have been absorbed.

Hatching.

The egg hatches when about 36 hours old, the hatching taking place usually in the evening of the second day after the egg is laid. Text-fig. 1*h* shows an egg which is just about to hatch. Hatching is a quick process, the tail coming out first, and the larva smartly wriggling itself out of the egg membrane. This first energetic act apparently exhausts the larva which is burdened with a massive yolk-sac. and hence it reaches a near-by mesh and rests there in any pose, horizontal or inclined, generally with the belly turned upwards.

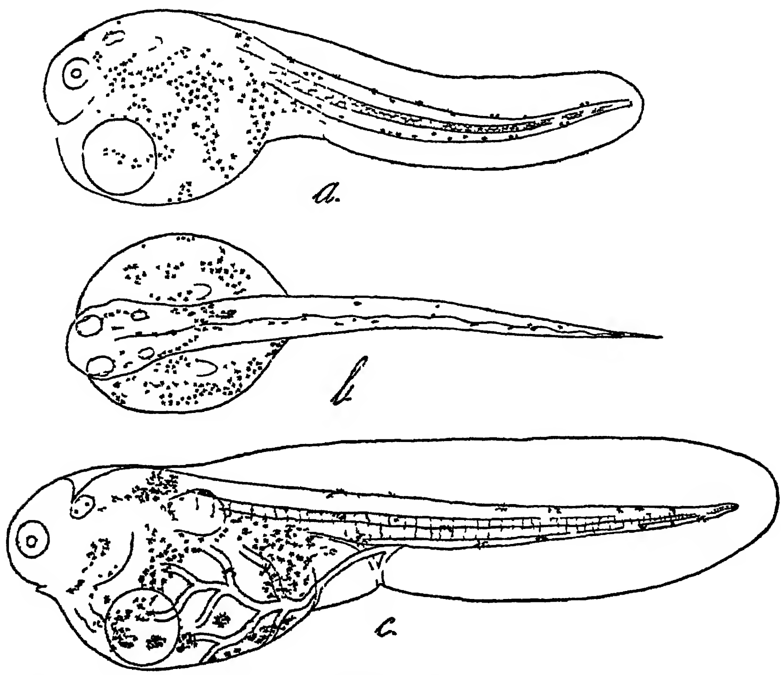
Newly Hatched Larva.—The newly hatched larva (text-fig. 2 *a*, *b*) is about 3·4 mm. long. and looks very much like a tiny tadpole. It is transparent and delicate, with well developed dark grey pigmentation. The pigment is disposed in an irregular patchy network on the large, projecting, rounded yolk-sac and on the head. It also extends in the form of small, sparingly scattered patches to the tapering body, especially towards its dorsal and ventral aspects. The head has a depressed appearance, and remains adpressed to the yolk. The body is slender, and narrows posteriorly into a straight tail. There is a wide, delicate, median fin-fold which commences at the nape and extends over the back and round the tail right up to the yolk-sac below. Against the anal region the fin-fold is marked by a very faint notch at its margin and a loop of a blood vessel through its width. The pectoral fin buds are laterally disposed, and stand out in the thoracic region over the yolk-sac. The notochord is simple and unsegmented. Occasionally the larva moves about briskly by quick, side to side movements of its wide tail to short distances, but soon resumes its motionless posture.

Metamorphosis.—As described above, the larva is remarkably different from the adult. Metamorphosis has been found to be a prolonged process, and it takes about a month for the characters of the young adult to be established. However, as the period of embryonic development inside the egg is short, the early larval development of the hatchling is fairly quick.

Twelve hours old larva.

In the course of twelve hours after hatching a fair portion of the yolk is absorbed, though much of it still projects (text-fig. 2*c*) as a pear-shaped structure on the ventral side. The head is distinct from the yolk-sac, and the small mouth appears as a crescentic pit on its ventral aspect. The opercular flaps also get differentiated. The pectoral buds grow out into broad fins, which though without rays, are very active, and keep on flapping even when the larva is stationary. The pigmentation

on the body becomes denser; paired lateral patches make their appearance. The eyes begin to grow dark. The notochord becomes



TEXT-FIG. 2.—*Mastacembelus pancalus* (Hamilton), early larval forms.

a. Lateral view of a newly hatched larva: × *ca*. 24; *b*. Dorsal view of the same *c*. Lateral view of a larva twelve hours old: *ca*. 28.

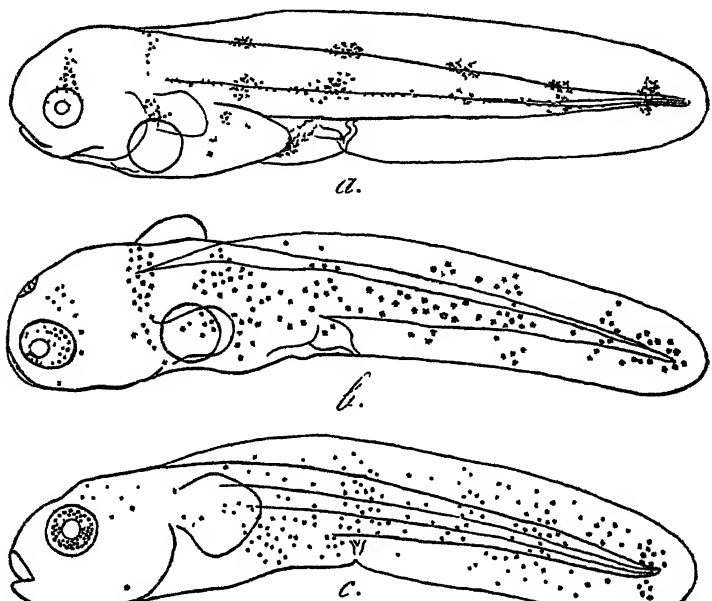
segmented, and rudiments of vertebrae begin to appear. The heart beats about 175 times a minute. The larva continues to be of inactive habits, resting on the algal mesh or lying on its back or side at the bottom for long intervals. When disturbed, or sometimes even of its own accord, it suddenly darts up and briskly jerks about for a short while.

Two days old larva.

A two days old larva (text-fig. 3*a*) is 4·8 mm. long, with the yolk further reduced, but with the oil globule still present. The head is quite pronounced, being stout and nearly truncate, dorsally sloping backwards. The mouth is well formed and subterminal in position. The mandibles are clearly marked off from the buccal floor. The operculum is well differentiated. The heart-beats are 175 per minute. The eyes are only slightly darker than before. In the median fin-fold there is not much change except that the portion in front of the anal region is slightly reduced. The pectorals are firmer, though still without rays. The pigment patches are conspicuous on the body. They are concentrated in dark areas above the eyes, at intervals on the body, especially towards the dorsal and to a less extent on the lateral aspect of the body, and on the abdomen. Some of the patches extend slightly to the fin-fold also. The larva is more agile than before, and at intervals, between periods of rest, it lashes about briskly.

Four days old larva.

A four days old larva (text-fig. 3*b*) is 5·1 mm. long. Most of the yolk is absorbed. The pre-anal fin-fold is reduced. The pectoral fins are larger. The chromatophores are more scattered in their arrangement; but in some areas they are in fairly dense patches, one occipital, one thoracic, one abdominal and five caudal—all extending to the median fin-fold.



TEXT-FIG. 3.—*Mastacembelus pancalus* (Hamilton), larval forms in the early stages of metamorphosis.

a. Two days old larva: × *ca*. 19½; *b*. Four days old larva: × *ca*. 18½; *c*. One week old larva: × *ca*. 16¾.

A week old larva.

By the seventh day the larva (text-fig. 3*c*) grows to 5·7 mm. in length. The contour of the head begins for the first time to show a slight indication of the future conical snout. The yolk is completely absorbed, and with the well formed mouth which is now terminal, the larva starts feeding on microplankton in the water. The eyes are well developed and look black with a beautiful brownish yellow ring around the central black area. The operculum appears ribbed owing to the formation of branchiostegals. The hyaline looking body of the larva begins to assume a faint yellowish opacity, which is due to (1) development of denser musculature, (2) more blood vessels and (3) the chromatophores scattered as lighter specks all over the body. The pre-anal part of the fin-fold has been completely absorbed, and the hind portion of the abdomen reaches up to the anus, which is fairly posterior in position. The posterior vertebrae of the long tapering tail are slightly upturned at this stage. The pectoral fins are large and firm with a basal cartilage. Radiating folds from the basal cartilage give a false appearance of rays, but true rays

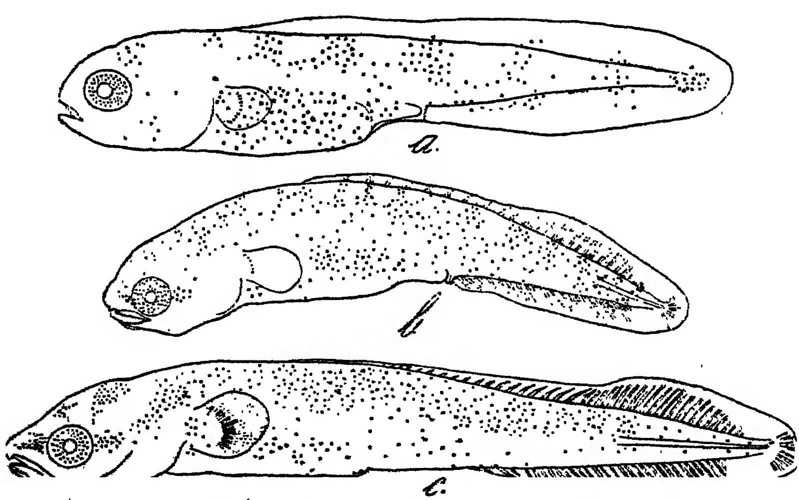
are yet absent. Though stronger than before, the larva still exhibits only intermittent activity, and indulges in frequent periods of rest in various postures in the algal mesh. Sometimes, when at the bottom, it creeps about or shoots smoothly forward and glides with its crest-like median fin-fold erect, the body being slightly arched as shown in the figure.

Ten days old specimen.

By the tenth day (text-fig. 4*a*) the length increases to 7·4 mm. The snout begins to assume a definitely conical shape. The body grows stouter. The median fin-fold in the anterior region of the back gets narrower. The pigmentation retains more or less the earlier pattern. The eyes, which had been flush with the general surface of the head, now stand out from it. A lip-fold appears and grows thick and fleshy at the angles of the mouth.

Twelve days old specimen.

The length is 10 mm. by the twelfth day (text-fig. 4*b*). The lip fold becomes more pronounced. The trilobed tip of the adult snout makes its first indication as the result of the growth of a pair of tiny lateral buds from the sides of the extreme tip of the snout. The anterior nostrils are carried at the ends of these buds. The median fin-fold gets narrower,



TEXT-FIG. 4.—*Mastacembelus pancalus* (Hamilton), intermediate stages of metamorphosis.

a. Ten days old specimen: × *ca.* 12¼; *b.* Twelve days old specimen: × *ca.* 8; *c.* Two weeks old specimen: × *ca.* 8¼.

as the body including the tail grows stouter. The future spinous portion of the dorsal fin gets markedly narrower than the rest of the fin-fold in which rays begin to make their appearance. Eighteen true rays appear in the region of the soft dorsal, twenty-one in that of the soft anal and five in that of the caudal. All the three spines in the anterior part of the anal and ten spines in that of the dorsal also begin to appear. The pectorals are larger, but still devoid of true rays. The anus becomes

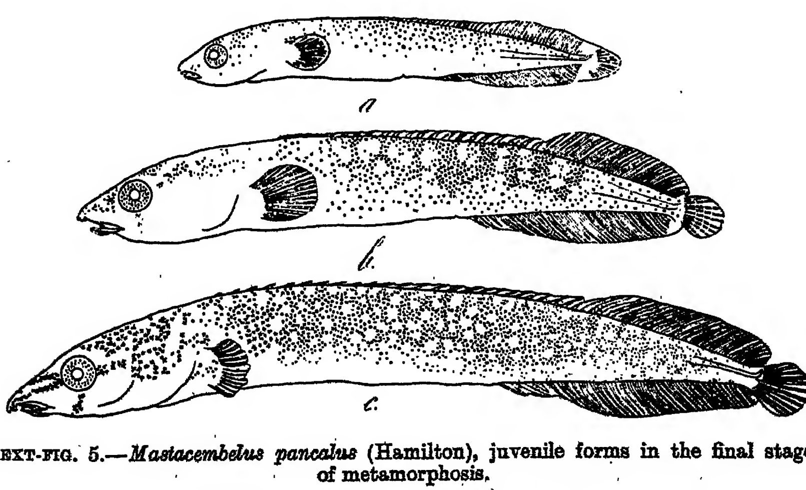
more posteriorly placed as the abdomen elongates. The pigmentation begins to show for the first time slight indications of the adult bands. Along the back the chromatophores are arranged in the form of irregular bands leaving large ovoid pigmentless patches of which there are about ten to be seen on each side of the body. On the head the adult ocular band is indicated as a discontinuous band in front of and behind each eye.

Two weeks old specimen.

When two weeks old, the specimen (text-fig. 4*c*) is 12·9 mm. long. The snout is more conical, and the terminal lobes of the upper jaw grow out making the mouth sub-terminal. The fleshy lip-folds at the angles of the mouth are more conspicuous. The preopercle can now be distinguished. The three anal spines are well formed, the second being the longest. Twenty-five rays are developed in the soft dorsal, twenty-seven in the soft anal and nine in the caudal, which last, however, is still confluent with the rest of the fin-fold. Indications of about twelve true rays are present in the pectoral. Eighteen spines of increasing length from front backwards appear in the anterior part of the dorsal fin-fold. The latter becomes narrower and the anteriormost part of it is absorbed. The faint pigment spots on the body begin to spread, leaving small, clear, circular patches, which are fore-runners of the greyish white spots of the adult fish. The ocular band of pigment becomes more extensive and darker.

Two and a half weeks old specimen.

By the middle of the third week the length reaches 15·2 mm. (text-fig. 5*a*). The pigmentation gets deeper in shade on the dorsal aspect.



TEXT-FIG. 5.—*Mastacembelus pancalus* (Hamilton), juvenile forms in the final stages of metamorphosis.

a. Two and a half weeks old specimen: × *ca.* 4; *b.* Three weeks old specimen: × *ca.* 4¾; *c.* One month old specimen: × *ca.* 5.

The anterior part of the dorsal fin is narrower and has twenty spines. The number of rays increases in the fins. The portions of the vertical fin-fold just in front of the caudal, above and below, are devoid of rays, and begin to show signs of atrophy.

Three weeks old specimen.

By the end of the third week the length becomes 18 mm. (text-fig. 5*b*). The snout gets elongated with well pronounced lobes at the tip. The posterior nostrils are now distinctly marked. Twenty-three spines are well marked in the anterior part of the dorsal fin : the interspinous membrane nearly stops short of the ends of the spines. The portions of the fin-fold immediately in front of the caudal have been absorbed and as a result the caudal is quite separate from the dorsal and the anal. There are thirty-two soft rays in the dorsal, thirty-five in the anal, eleven in the caudal and sixteen in the pectoral.

A month old specimen.

Metamorphosis is practically complete by the end of the first month. The length reaches about 22 mm. (text-fig. 5*c*). The snout, though still proportionately shorter than in the adult, assumes more or less the characteristic shape of the adult with a well defined, mobile, trilobed tip. Twenty-five spines are seen in the spinous dorsal, the anterior spines being short, sharp and devoid of any interspinous membrane. Thirty-three rays are present in the dorsal and thirty-seven in the anal. The caudal fin is rounded and has twelve rays. The pectoral has eighteen rays. The colouration, though not fully developed, is bright and approaches the adult pattern the bands being well indicated and extending even to the dorsal and anal fins. Thus in a month's time the fish practically becomes a young adult.

As the fish grows the full adult features are gradually assumed. When ten months old the fish[1] reaches a length of 96 mm., and the gonads begin to mature. Evidently, as suggested by D'Abreu (*loc. cit.*), the species attains sexual maturity in the course of a year.

BIONOMICS.

Habits.—*Mustacembelus pancalus* lives in clear as well as muddy fresh waters of tanks, rivers, lakes, borrow pits, etc., but is an occasional immigrant to slightly brackish waters. It prefers a bottom of soft mud in which it can easily burrow, for which purpose its body is admirably adapted. In the natural habitat the young often glide about among algae and fine-leafed water plants, while the adults frequent the loose mud or lurk in narrow crevices near the banks. In the aquarium the fish spends most of the day time buried in the sand, part of the head alone usually protruding out. In this position, especially when silt accumulates on the exposed part of the head it easily escapes notice. This habit provides a perfect camouflage for both attacking its prey and escaping from its natural enemies. At night, however, it freely swims about, mostly at the bottom. But like other nocturnal fishes it can be trained to eat in day time, though, as soon as it has had its meal, it quickly returns to its shelter below. The act of burrowing was closely observed on several occasions. The fish glides about the bottom, nosing the substratum with its mobile, trilobed, sensitive snout and, selecting

[1] This description is based on those specimens which developed from the 18 mm. larvae collected in June.

a suitable spot, wriggles itself into the substratum by a brisk side to side and forward movement, until most of the body and tail are concealed. Sometimes the tail sticks out as also the tip of the head. On being disturbed from its burrow, it darts about for a while, and selecting another spot, makes a fresh burrow or sometimes returns to its original burrow. Half buried reeds and hollows are often its favourite resorts and this accounts for its habit of lurking about in cracks and crevices near the banks. Hence a common method of catching the fish is by leaving old, cast-off pipes or hollow bamboos here and there in pools and lifting them out along with the fish in them. The fish, however, is sometimes caught on rod and line, and villagers capture it also by raking the mud with a bent trident.

Hibernation and Aestivation.—Being capable of aerial respiration[1], the Spiny Eels burrow in the soil when the waters dry up. Specimens of *Rhynchobdella aculeata* have been exhumed (Day, 1877, p. 214) from the dried beds of ponds. A pair of *M. pancalus* were found deep under the mud in a drying pool at Ulubaria. In the cold winter months even in the presence of water in the aquarium *M. pancalus* was often noticed to bury the greater portion of its body including its snout in the mud and remain inactive for longer or shorter periods, the opercular flaps, when visible, being seen to exhibit no respiratory movement. The fish thus appears to be capable of resorting to longer or shorter periods of hibernation during which even the breathing movements are suspended.

Food.—The gut-contents of seventy specimens of the fish, ranging from 1 cm. to 14·5 cm. were studied more or less along the lines of those of the Perches and of the Killifish (Job, 1940, pp. 293-295 ; 1941). In the young stages the fish is found to subsist mainly on Entomostracan Crustacea, the items in the order of preponderance being Daphnids, like *Macrothrix orientalis*, Ostracods and traces of Cyclops, and larvae of insects such as *Ceratopogon* sp. and other Chironomids, Coleopterans and occasionally larvae of mosquitoes and other Dipterans. As the fish grows larger the proportion of insect larvae increases, and larger Crustacea begin to form a fair portion of the diet. Only in one instance were Teleostean remains noted among the gut-contents ; these consisted of a single egg and part of a fin.

Economic Importance.

Like the true eels, the Spiny Eels are regarded by many as excellent for the table. One of the congeners, *Mastacembelus armatus*, grows to three feet, and D'Abreu (*op. cit.*, p. 32) lists it as the most important food fish after the murrels in the Ambajheri tank at Nagpur. Hamid Khan (1934, p. 667) notes that its flesh is firm and tough, and said to be invigorating, but adds that in the Punjab, the Spiny Eels are shunned like snakes and are eaten mostly by low caste and poor people. More or less the same may be said about true eels as well ; for, while considered a delicacy by many, they are equally shunned in several districts

[1] For details of aerial respiration in the Spiny Eels, *see* Dobson, 1874, p. 312 ; Day, 1889, p. 332 ; Deraniyagala, 1932, p. 266 ; Ghosh, 1934, pp. 328, 329 ; and Hora, 1935, p. 8.

owing to popular prejudice due to their snake-like shape[1]. *M. pancalus* grows only to seven inches, and though edible, is of less market value than its congeners. As fish remains were found only in one out of the seventy specimens of *M. pancalus* examined, the species does not appear to be so piscivorous as *M. armatus*, which has been noted (Hamid Khan, *loc. cit.*) to be "very destructive to eggs and fry of other fish."

The proportion of mosquito larvae in the gut-contents of the fish is insignificant and hence it is clear that though to a small extent the fish may help to reduce the numbers of larvae in marshy pools, it is not of any cognizable value in the control of mosquitoes. Again, as explained elsewhere (Job, 1941*a*), the proportion of Cyclops met with in the food of the species is too small to have any significance in the control of guinea-worm.

As far as parasites are concerned, while Rahimulla and Das (1935, p. 34), who studied collections of the fish from Hyderabad, report that "no parasites have been found" in the specimens examined by them, in several adult specimens from Ulubaria examined by the writer, numerous Trematodes and Nematodes, free as well as encysted, were observed. No parasites were seen in the younger stages of the fish.

SYSTEMATICS OF THE MASTACEMBELIDAE.

Günther (1861, p. 539) writes, "The structure of the mouth (not of the bones of the upper jaw) and of the gill-apparatus, the separation of the humeral arch from the skull, the absence of ventral fins, the anatomy of the internal parts, and the whole habit, afford ample proof that these fishes are eels, in which a part of the dorsal fin is spinous". He, however, mentions the presence of the air-bladder and pyloric appendages in the Mastacembelidae, while they are absent in the true eels. Besides, as Deraniyagala (*op. cit.*, p. 265) states, "the presence of dorsal and anal spines, normal ovisacs, oviducts and spawning in fresh-water" exclude these fishes of uncertain relationship from the Apodes. Again, whereas the eels are considered to be of ancient origin, being represented not only in all fresh waters and seas of the temperate and tropical zones of modern times, but also in fossils like those of Monte Bolca, Aix and Oeningen (*vide* Günther, 1880, p. 670), the Mastacembelidae are comparatively less ancient, being specialised for life in muddy bottom ecology, and, as mentioned by Meek (1916, p. 314), not known to be represented as fossils. It is believed (*vide* Chaudhuri, 1916, pp. 12, 13) that the Mastacembelidae evolved originally in India and spread over to China in the east and to Africa in the west, as "the most primitive forms are found only in this country and the extreme forms in China and Africa, with the intermediate forms in the intervening countries." From the external characters and the indications of the skeleton, Regan (1912, p. 218) concludes that "these fishes are related to, but more specialized than, the Percomorphi", though he could not trace their affinity to any particular group of Percomorph fishes. The general percoid

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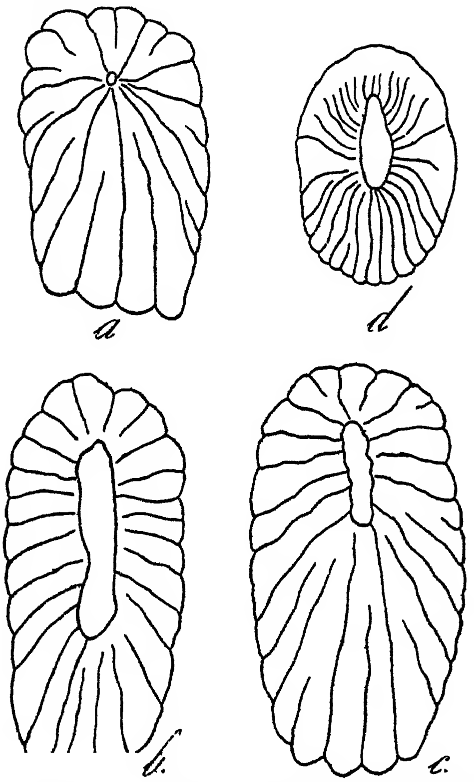
[1] Hamilton (1822, p. 27), has however, stated, "The fishes of the *Macrognathus* [*Mastacembelus*] genus have less of a disgusting appearance than those called *Muraena*, and are more sought after by the natives; the highest of whom in Bengal make no scruple of eating them; and by Europeans they are esteemed the best of the eel kind".

appearance, so marked in the early larvae of *M. pancalus*, lends support to Regan's surmise. Further, the similarity in distribution, the presence of dorsal and anal spines, and the similarity in the scale pattern seem to indicate that the Mastacembelidae might have originated from a Percoid fish remotely allied to Nandidae. The scales of Mastacembelidae are longer than broad, with basal, apical and lateral radii as in those of *Plesiops* Cuvier, a genus of Nandidae. While the nuclear area is very



TEXT-FIG. 6.—Outline diagrams of typical scales from the broad sides of fishes of the Mastacembelidae and *Plesiops* Cuvier (Nandidae).

a. Mastacembelus pancalus (Hamilton); *b. Mastacembelus armatus* (Lacép.); *c. Rhynchobdella aculeata* (Bloch); *d. Plesiops nigricans* Rupp. (*a*, *b* and *c* are magnified about 32 times and *d* about 4½ times. The circuli are not represented).

small and narrow in *M. pancalus*, it is wider in *M. armatus* and *Rhynchobdellaaculeata*, and very wide in *Plesiops* (text-fig. 6). The margins of the scales of all these are scalloped in varying degrees. The narrow nature of the scales of the Mastacembelidae may be a modification necessitated by their burrowing habits. The modification of the pelvic fins, which are absent in *Mastacembelus*, is also apparent in *Plesiops*, where there are fewer rays in the pelvics. The general resemblance of the twelve days old larva of *M. pancalus* to *Plesiops* is again striking. In the absence of a detailed knowledge of the anatomy of the Mastacembelidae and the Nandidae it is not possible, however, to arrive at any more precise conclusions in regard to their relationships. The above is merely a tentative suggestion.

Summary.

The life-history of *Mastacembelus pancalus* (Hamilton) was worked out by following the development of its eggs collected from a Railway borrow pit between Ulubaria and Fuleshwar in the Howrah District, where the fish breeds from May to November with the peak period during the pre-monsoon rains. The fairly large eggs are laid. scattered in groups among algal meshes. Though the egg is heavily yolk-laden. the embryonic development is very short. and hatching takes place a day and a half after laying. The hatchling looks very different from the adult, and resembles a tiny tadpole. Being still heavily yolk-laden, it seldom moves about, but usually rests belly up for long intervals on the algal mesh. The early larval development is fairly rapid. Metamorphosis, however, is prolonged over a month. The yolk gets fully absorbed in the first week, and the larva begins to feed on microplankton, though active movement is still intermittent. In the course of the next two weeks the conical snout with its trilobed tip is developed, the median fins get differentiated with spines and rays, which latter appear in the pectorals also, and active swimming and wriggling movements commence. By the end of the first month there develops the 22 mm. long young adult with full complement of fin-rays and other characters of the adult fish. Maturity is attained in about one year.

Normally a nocturnal fish, *M. pancalus* usually spends the day time lurking in narrow crevices or in temporary burrows, which it makes in the soft substratum. In the young stage the fish feeds mostly on Entomostracan Crustaceans and certain insect larvae. The ratio of piscine elements in the food is negligible. In very cold and dry seasons the fish hibernates for longer or shorter periods.

Though small in size, and shunned by some owing to the snake-like shape, the fish is regarded good eating by many. Unlike *M. armatus*, *M. pancalus* is not very destructive to eggs and fry of other fishes. Its value in the control of mosquitoes and Cyclops is insignificant. The fish is frequently subject to parasitism by Helminths.

Regarding systematics, the general Percoid appearance of the early larvae of *M. pancalus*, the similarity in distribution, the presence of dorsal and anal spines, the similarity in the scale pattern, the modification of pelvic fins, and the general resemblance of the twelve days old larva of *M. pancalus* to *Plesiops* seem to indicate that the Mastacembelidae might have originated from a Percoid fish remotely allied to Nandidae.

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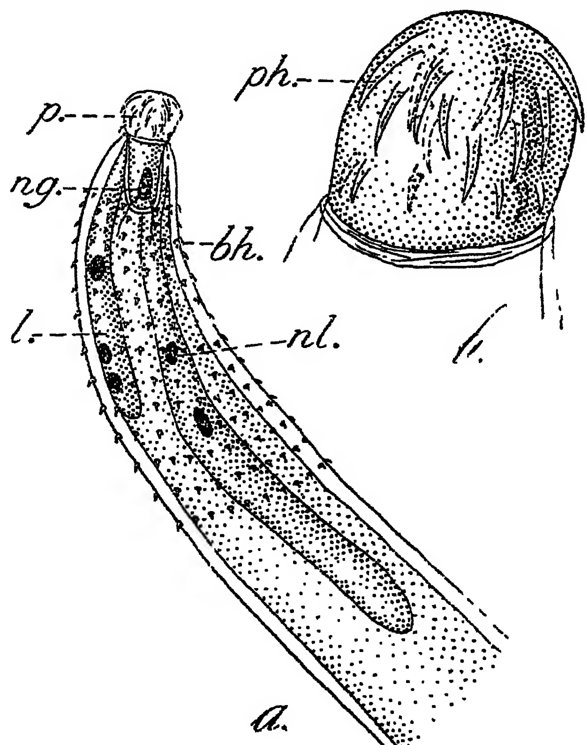
ON A NEW ACANTHOCEPHALA, *ACANTHOSENTIS SIRCARI*, SP. NOV., FROM A CALCUTTA FISH, *RASBORA ELANGA* (HAM.).

By T. N. PODDER, *M.Sc.*, *M.B.*, *Professor of Zoology, Carmichael Medical College, Calcutta.*

In the course of my investigations on the parasitic infections of various fishes of Bengal and other provinces available in the Calcutta markets, I found a new acanthocephalan parasite in the intestine of *Rasbora elanga* (Ham.). This fish is known in Bengal as "Elang bata", and is generally available in the local markets from September to March. I found that nearly 60 per cent of the fishes were infected with these parasites and the highest number of parasites in one specimen was 8-10; all the parasites were found in the intestine of the host. This worm is described below as *Acanthosentis sircari*[1], sp. nov.

Acanthosentis sircari, sp. nov.

The body is usually cylindrical with a broad anterior end, while the posterior portion tapers a little towards the extremity. Sexual dimor-



TEXT-FIG. 1.—Anterior portion of *Acanthosentis sircari*, sp. nov.

bh., body hooks; *l.*, lemnisci; *ng.*, central nerve ganglion; *nl.*, nucleus of the lemnisci; *p.*, proboscis; *ph.*, proboscis hooks.

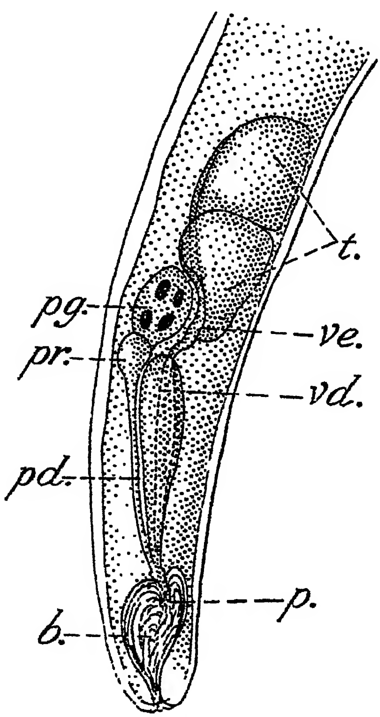
[1] The species has been named after Sir Nilratan Sircar, M.A., M.D., D.Sc., as a mark of gratitude for his keen interest in this line of research.

phism is well marked, the females being much larger than the males. The colour of fresh specimens is creamy-white.

The proboscis is globular with 3 rows of 6 hooks each. The hooks of the first and second rows are much larger than those of the third row. There is no definite neck, but in fully stretched specimens a comparatively small space, devoid of spines, corresponding to the neck can be distinguished.

The anterior half of the body is armed with circular rows of curved spines. In the anterior region these spines are closely set, but the rows near the middle are wide apart. In the body-wall there are a few giant sub-cuticular nuclei, five on the dorsal and two in the ventral aspect of the body, some branched nuclei are also present. The lacunar system is well developed. The transverse canals are very prominent, their course in the body-wall corresponds to the circles of cuticular spines and suggests a pseudosegmentation of the body.

The proboscis sheath is a single-layered, thin walled muscular sac, hanging down from the middle region of the proboscis. The central nerve ganglion is situated at the posterior extremity of the proboscis sheath.



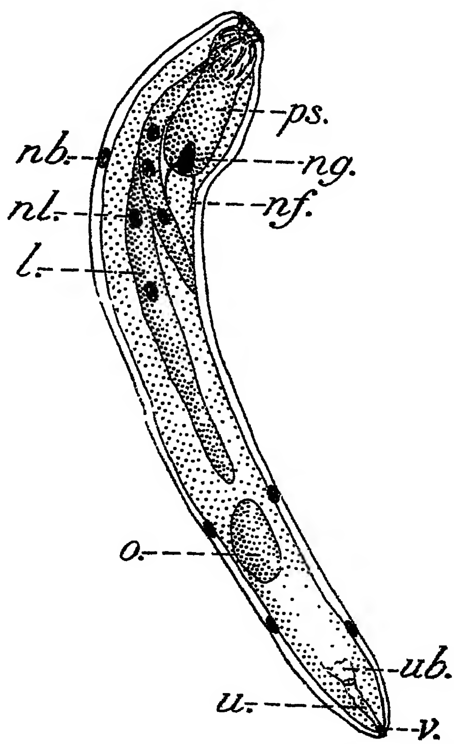
TEXT-FIG. 2.—Posterior portion of male *Acanthosentis sircari*, sp. nov.

b., bursa; *p.*, penis; pd. prostatic duct; *pg.*, Prostatic glands; *pr.*, Prostatic reservoir; *t.*, testes; *vd.*, vas deferens; *ve.*, vasa efferentia.

The two lemnisci are situated normally on either side of the proboscis sheath. One of the lemnisci is much longer than the other, being

nearly twice its length. This is a constant feature in all the specimens examined. There are three nuclei in the shorter lemniscus, and two in the longer.

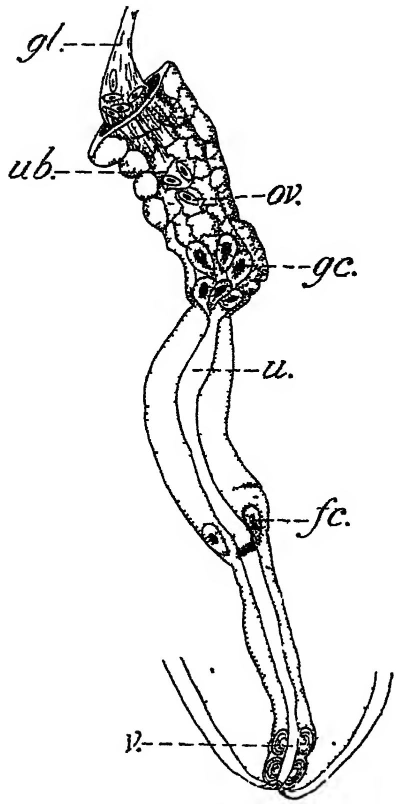
The male genitalia consist of two ovoid testes situated closely apposed to each other. The vasa efferentia join one another near the prostatic reservior to form a thick and elongated vas deferens which ends in the penis. The prostatic gland is a single syncitial mass with 6 to 8 nuclei embedded in it. It lies closely behind the posterior testis. The prostatic reservoir is a rounded organ which is continued as a narrow prostatic duct opening at the base of the penis. The seminal vesicle is a long baloon-shaped sac which also opens near the opening of the vas deferens into the penis. The penis is a conical muscular organ which ends at the top of the eversible bursa. The bursa is a funnel-shaped structure which, in most cases, is retracted within the body.



TEXT-FIG. 3.—Young female *A. sircari*, sp. nov. showing developing ovary. *l.*, lemnisci; *nb.*, body nucleus; *nf.*, nerve retinaculi; *ng.*, central nerve ganglion; *o.*, ovary; *ps.*, proboscis sheath; *u.*, uterus; *ub.*, uterine bell; *v.*, vagina.

The female genitalia consist of a thick walled uterine-bell which at its posterior end is continued as a long, tubular uterus. At the posterior extremity of the uterine-bell just near its opening into the uterus there are 5 to 6 giant cells, the " guard cells " which control the passage of the mature ova into the uterus. The wall of the uterus is thick, its posterior half is very muscular, and its lumen is much narrower posteriorly than anteriorly. At the junction of the anterior and posterior portions

of the uterus there are two giant cells situated within the uterine wall; these are the flask cells (Verma & Datta). The uterus leads into the thick and muscular vagina, which is situated at the postero-ventral end of the worm.



TEXT-FIG. 4.—Female genitalia of *A. sucani* sp. nov.

fc., flask cell; *gc.*, guard cell; *gl.*, genital ligament; *ov.*, ova; *u.*, uterus; *ub.*, uterine bell; *v.*, vagina.

Measurements.—Males 3·11—4·76mm. × 0·48—0·67mm.; females 2·94—11·89mm. × 0·39—1·01mm.; proboscis 0·138×0·115mm.; proboscis hooks, row (i) 0·055mm. long, row (ii) 0·048mm. long, row (iii) 0·018mm. long; proboscis sheath 0·265×0·150mm.; lemnisci (i) 0·920×0·104mm., (ii) 1·932×0·161mm.; testis, anterior 0·391×0·345 mm., posterior 0·379×0·322mm.; prostatic gland 0·253×0·207mm.; vas deferens 0·667mm. long; prostatic reservoir 0·161×0·104mm.; prostatic duct 0·598mm. long; bursa 0·437mm. long; uterine bell 0·115mm. long; uterus 0·133mm. long; vagina 0·161mm. long. Ova not liberated.

In the new species the males are generally much smaller than the females. The lemnisci are much longer than the proboscis sheath and one of the lemnisci is nearly double in length of the other. There are 3 nuclei in the shorter and 2 in the longer lemnisci. The wall of the proboscis sheath is single layered. The central nerve ganglion is situated

TABLE I.

Showing measurements of closely related species.

Name of species.	Sex.	Dimensions	Proboscis	Prob. Sheath	Lemnisci	Terminal Hooks	Sub-cuticular nuclei
A. antspinus Verma & Datta	♂	1 0–1 25 × 0 25–0 2 mm	0 04–0 17 × 0 04–0 05 mm	0 17 0 38 × 0 04 0·13 mm	0 04 0 17 0 04 0 07 mm both equal	3 rows of 6 hooks (i) 72μ (ii) 54μ (iii) 48μ	few oval & branched
	♀	2 0–3 0 0 75–1 0 mm					
A. holospinus Sen	♂	0 9–2 4 × 0 2–0 4 mm.	0 1 × 0 05 mm.	0 3 × 0 08 mm	Slender and little longer than the proboscis sheath		4 dorsal & 2 ventral
	♀	1 0–9 4 0 2 0 7 mm.					
A. dattai Podder	♂	1 34 3 34 0 24 0 42 mm	0 12 0 055 mm	0 42 0 12 mm	(i) 0 68 0 055 mm (ii) 0 59 0 055 mm Slightly longer than the proboscis sheath	(i) 0 05 mm (ii) 0 03 mm (iii) 0 026 mm	4 dorsal & 2 ventral
	♀	1 67 9 46 0 14 0 9 mm					
A. sarcari, sp. nov	♂	3 11 4 76 0 18 0 67 mm	0 138 × 0 115 mm	0 265 × 0 130 mm	Much longer than the proboscis sheath, one nearly double the length of the other	(i) 0 05 mm (ii) 0 018 mm (iii) 0 013 mm	4 dorsal & 2 ventral
	♀	2 94 11 89 × 0 39 1 01 mm			(i) 0 920 0 104 mm (ii) 1 952 0 161 mm		

near the posterior extremity of the proboscis sheath. The prostatic gland is a single, syncitial mass, with 6-8 nuclei and the lacunar system is well developed.

Host.—*Rasbora elanga* (Ham.)

Location.—Intestine.

Locality.—Calcutta, India.

Type specimens.—(Reg. No. W3445/1) Deposited in the collections of the Zoological Survey of India (*Ind. Mus.*), Calcutta.

In conclusion, I have to express my hearty thanks to Dr. Baini Prashad, Director, Zoological Survey of India, Calcutta, for giving me facilities to consult the literature in the library and to Mr. M. N. Datta of the same department for his valuable suggestions.

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SOME ASPECTS OF THE CRANIAL MORPHOLOGY OF *URAEOTYPHLUS NARAYANI* SESHACHAR (APODA).

By L. S. RAMASWAMI, *Department of Zoology, University of Mysore, Intermediate College, Mysore.*

(Plates IV—VI.)

CONTENTS.

INTRODUCTION.

The genus *Uraeotyphlus* was originally included under *Caecilia* (part) Dum. & Bibr. until it was shown by Peters (1879) how *Uraeotyphlus* differed from the other genera ; Peters, therefore, erected the new genus *Uraeotyphlus* to accommodate the three species known at the time. Nieden (1913), who followed Peters, included the three species of *Caecilia*,—*C. malabaricus*, *C. oxyuris* and *C. seraphini* under *Uraeotyphlus* ; but the last species of *Uraeotyphlus* has subsequently been shown to belong to *Geotrypetes* by Parker (1927). Two more species were added later, namely, *U. menoni* and *U. narayani*, making in all four Oriental species. The last one was recently described by Seshachar (1939).

The important difference between the commonly occurring South Indian genera *Ichthyophis* and *Uraeotyphlus* in the arrangement of cranial bones is that in the former the parietal and squamosal approximate together dorsally (stegokrotaphy) while in the latter, a gap separates them (zygokrotaphy). The genera *Dermophis*, *Hypogeophis*, *Caecilia*, *Cryptopsophis*, *Amphiumophis*, *Herpele*, *Gymnopis*, *Typhlonectes*, *Siphonops*, *Boulengerula* and *Gegenophis* are related to *Ichthyophis* in regard to the arrangement of the parietal and squamosal while the remaining genera *Rhinatrema*, *Geotrypetes*, *Praslinia*, *Bdellophis*[1] *Chthonerpeton* and *Scolecomorphus* conform to the *Uraeotyphlus* plan. Recently Parker (1936) described a new genus from Cameroon, South Africa,—*Idiocranium* : in this also the parietal is not separated from the squamosal by a wide gap.

Wiedersheim (1879) having examined a single specimen of *Caecilia oxyura* (*U. oxyurus*) came to the conclusion that anatomically it was not very different from *C. lumbricoides* (*C. gracilis*) and *C. rostrata* (*Hypogeophis rostratus*), and remarked that the latter two species could very well be treated together. I reproduce his sentence (p. 27) here, for it chiefly concerns the genus *Uraeotyphlus* which is discussed in the present paper :

> "*Caecilia lumbricoides* und *Caecilia rostrata*. Beide Arten zeigen nur so geringe Abweichungen dass sie fuglich zusammen abgehandelt werden konnen. Dasselbe gilt auch *C. oxyura*, insoweit er mit gelungen ist, an dem einem mir zu gebote stehenden Examplare ins klare zu kommen."

The cranial morphology of a large number of Apodan members was described by Wiedersheim, *viz.*, *I. glutinosus*, *C. lumbricoidea* (*C. gracilis*), *C. rostrata* (*H. rostratus*), *C. oxyura* (*U. oxyurus*), *Siphonops annulatus*, *Siphonops indistinctum* (*Chthonerpeton indistinctum*) ; of these the accounts of the skull, hyoid apparatus, olfactory and auditory organs, the tentacle, the brain and its nerves chiefly concern us. It should be noted, however, that he described a species of *Uraeotyphlus* (*U. oxyurus*) as belonging to the genus *Caecilia* and similarly his two other examples *C. rostrata* and *S. indistinctum* are now regarded as species of the genera *Hypogeophis* and *Chthonerpeton* respectively.

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[1] *Bdellophis* is merged with *Scolecomorphus*, see Barbour and Loveridge, 1928,

Peters (1881) noted that the skull of *Uraeotyphlus* closely resembled that of *Ichthyophis*, and, therefore, both differed considerably from that in the other genera. He described the gross morphology of the skull of *U. oxyurus*, having studied two specimens and remarked that the founding of the genus was definitely established. Describing the skull of *U. oxyurus*, he recorded the occurrence of separate intermaxillaria (premaxilla), a side piece on either side of the nasal (septomaxilla), a prefrontal, an orbital (postfrontal) and a pterygoid. The skull of *Uraeotyphlus* closely resembles that of *Ichthyophis* both coming from the same locality (South India)[1] except that the prefrontal does not reach the detached nasale (septomaxilla), and there is a gap between the squamosal (squamosojugale of Peters) and parietal. It is, however, significantly pointed out by Peters that these features may be individual variations or due to differences in age.

My object has been to describe in detail the morphology of the head of *U. narayani* and try to compare the anatomical details of this species with what has been described for other genera and finally to decide whether the erection of the new genus is justifiable.

MATERIAL AND METHODS.

The heads of larval and adult specimens of *I. glutinosus* and *U. narayani* secured from the Western Ghats were fixed in suitable fixatives (Bouin, Formol) and decalcified in a mixture of 70 per cent. alcohol containing 3 per cent. con. nitric acid (with phloroglucin). Alizarin transparencies of larval and adult animals were made for checking the skull preparations obtained by maceration. Sections were stained in Haematoxylin-eosin, Pasini, boraxcarmine-picro-indigocarmine and mucicarmine.

The entire lengths of the larval forms of *I. glutinosus* and of a juvenile specimen of *U. narayani* studied were as follows :

I. glutinosus : 3·8 (embryo), 7·0, 8·3, 10·0 and 12·7 cm.
U. narayani : 9·0 cm.

A single adult head of *Ichthyophis monochrous* was also sectioned for comparison. Heads of *Dermophis gregorii* Blgr., *Herpele ochrocephala* Cope, *Scolecomorphus uluguruensis* Barb. and Lov., and *Boulengerula boulengeri* Torn. were also sectioned and studied.

OBSERVATIONS.

The skull.—It is customary to study the skull by dividing it into regions, *viz.*, frontal, parietal, occipital, palate and upper jaw, suspensorium and bones in association with the sense-capsules. But in the apodan skull where some of the bones fuse with adjacent ones, a

[1] Sarasins (1890) remark that one species of *Uraeotyphlus*, *U. africanus* (*U. seraphini*, Nieden 1913) is found in Africa, while there is not even a single record of the occurrence of an *Ichthyophis* from the Ethiopian Continent; Parker (1927), however, correctly referred this species of *Uraeotyphlus* to *Geotrypetes* and thus removed a distributional anomaly.

narration based on this classification would entail a repetition of certain parts and therefore, I have adopted the following mode of description :

NASO-ETHMOID REGION :

The nasal } (bones in association with the olfactory
The septomaxilla } capsule).
The sphenethmoid.
The cartilages of the nasal region.

ORBITO-TEMPORAL REGION :

The frontal
The parietal
The pre- and post-frontal
(the frontal, pre- and post-frontals belong to the orbit; the parasphenoid and pleurosphenoid which belong to this region are described under the occipito-auditory region).

OCCIPITO-AUDITORY REGION :

The os Basale
The stapes.

THE UPPER JAW, PALATE AND SUSPENSORIUM :

The premaxilla
The maxillopalatine
The pterygoid
The prevomer
The squamosal
The quadrate

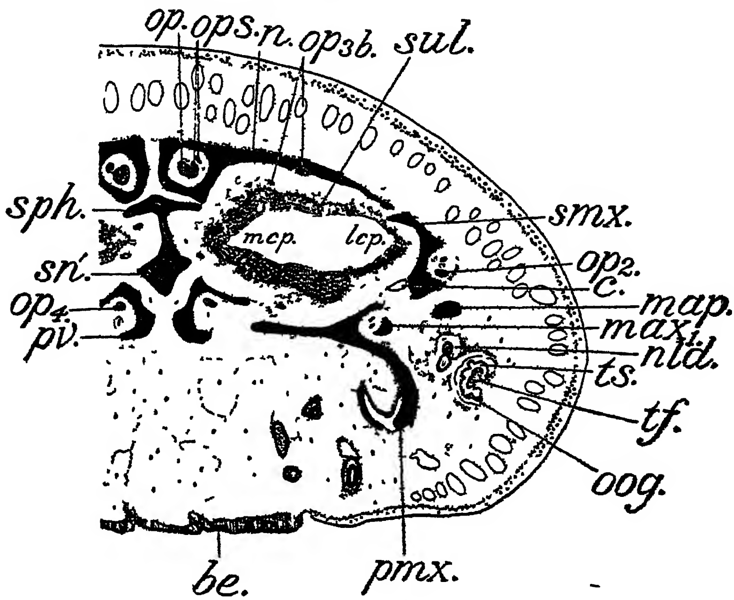
The only cartilage bones in the skull of Apoda are the os Basale, the stapes, and the quadrate.

Naso-ethmoid region.

The nasal (paired).—The nasals appear anteriorly as two vertical pieces of bone on either side of the prenasal prong. Posteriorly (*see* text-figs. 1, 8, 9, *n*) a horizontal piece is noticed dorsally to the olfactory chamber and the two (vertical and horizontal of each side) unite to enclose the main trunk of the ophthalmicus profundus nerve. This feature of the roofing bone (Pl. IV, fig. 1) is noticed till we reach the frontal which appears underneath the nasal and a few sections posteriorly the nasal disappear.

The septomaxilla (paired).—(*Nariale*, Marcus, Stimmelmayr and Porsch 1935). The septomaxilla (Pl. IV, fig. 1, text-fig. 1, *smx.*) which is noticed anteriorly to the appearance of the maxillopalatine in sectional views gives exit (through foramen epiphaniale ?) to a branch of the ophthalmicus profundus (op_2) nerve and is not united with the nasal (*n.*) above or with the premaxilla (*pmx.*) below. The contour of the bone in *Uraeotyphlus* differs slightly from that in *Ichthyophis*. A figure of a model of the septomaxilla is given by Sarasins (1890) where an upper, an external and an internal lamella are delineated. In *U. narayani* it appears posteriorly to the anterior naris as a small]-shaped

bone clasping the lateral portion of the olfactory sac ; the dorsal limb extends towards the nasal. while the lower limb is in contact with a cartilage (*c*). Anterior to the appearance of the prefrontal, the septo-



TEXT-FIG. 1.—*Uraeotyphlus narayani* Seshachar.

Transverse section in the septomaxilla region, posterior to fig. 8 : ×33.

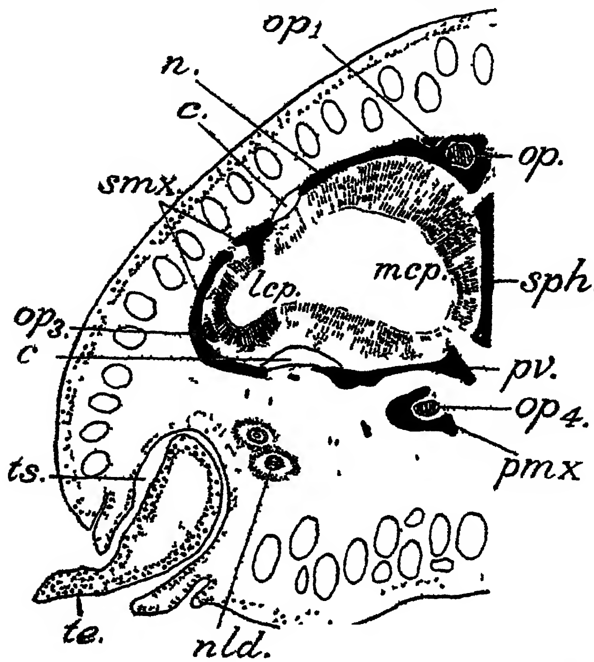
be., buccal epithelium ; *c.*, nasal cartilage ; *lcp.*, lateral cavum nasale principale : *map*, maxilloplatine bone ; *mar*$_1$., medial division of r. maxillaris V ; *mcp.*, median cavum nasale principale ; *n.*, nasal bone ; *nld*, nasolacrimal duct ; *oog.*, opening of orbital gland ; *op.*, r. ophthalmicus profundus V ; *op*$_2$., branch of r. ophthalmicus profundus ; *op*$_3$*b.*, branches of *op*$_3$. ; *op*$_4$., branch of r. ophthalmicus profundus ; *ops.*, branches of *op* to skin ; *pmx.*, premaxilla ; *pv.*, prevomer ; *smx.*, septomaxilla ; *sn'.*, ossified septum nasi ; *sph.*, sphenethmoid ; *sul.*, sulcus ; *tf.*, tentacular fold ; *ts.*, tentacular sac.

maxilla disappears from sections. In the juvenile specimen of *Uraeotyphlus* that I have examined, the septomaxilla has not reached the maximum development noticed in the adult. but the adult configuration and the passage of the nerve (*op*$_2$) can be clearly made out.

In *Scolecomorphus* (text-fig. 2, *smx.*) anterior to the external naris the septomaxilla appears as a small piece of bone on the ventral aspect of the olfactory sac externally to the premaxilla ; in the plica which depends into the cavum nasale principale, a portion of the bone is noticed which however, in posterior sections, unites with the limb situated below the cavum nasale principale after the latter bone gives exit to a branch of the ophthalmicus profundus (*op*$_3$). The septomaxilla forms a horseshoe-shaped bone in the hollow of which the lateral part (*lcp.*) of the cavum nasale is located. The bone disappears in the region where the eye and prefrontal appear in sections.

The sphenethmoid.—This bone starts in the nasal septum (text-fig. 1, *sph.*) and invades the preoptic roots also. Anteriorly the bone appears as a median pillar and on the dorsolateral aspects of which the broad internal portion of each nasal rests. Ventrally the sphenethmoid

is slightly broadened with a cartilaginous tip (*see* cartilages of the nasal region). Posteriorly the sphenethmoid encloses the dorsal and ventral olfactory divisions of the nervous olfactorius (text-figs 3, 9, *don*, *von*)



Text-fig. 2.—*Scolecomorphus uluguruensis* Barbour & Loveridge.

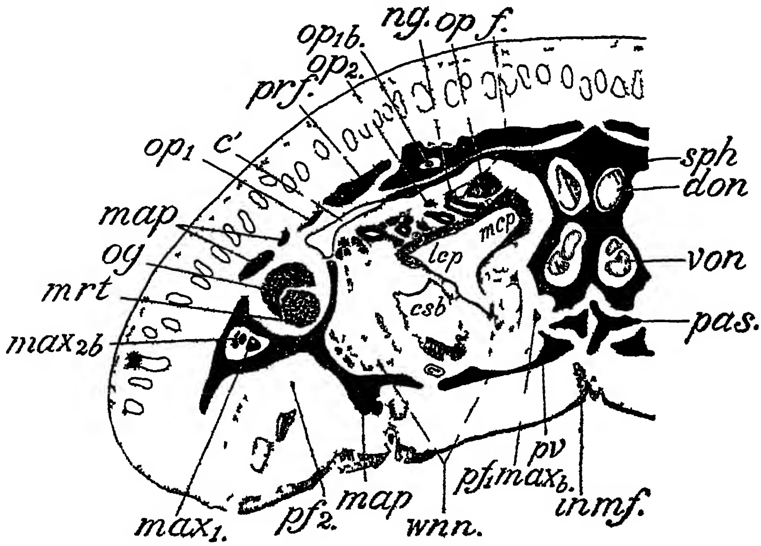
Transverse section in the septomaxilla region × 55.

c, nasal cartilage; *lcp*, lateral cavum nasale principale; *mcp*, median cavum nasale principale; *n*, nasal bone; *nld*, nasolacrimal duct; *op_1*, *op_3*, *op_4*, branches of r. ophthalmicus profundus; *pmx*, premaxilla; *pv*, prevomer; *smx*, septomaxilla; *sph*, sphenethmoid; *te*, tentacle; *ts*, tentacular sac.

and in a slightly prechoanal region, five canals can be made out, two dorsal for the dorsal olfactory nerves, two ventral for the two ventral olfactory nerves and a median one (*see* text-fig. 9 *von_b*) in which a branch of the right ventral olfactory nerve runs. In text-fig. 3, a large bony extension running dorsally to the olfactory chamber on each side is given off and in this region, only four canals can be seen in the sphenethmoid. The gap between the lateral extension of the sphenethmoid and a dorsal limb of the maxillopalatine is bridged by a piece of cartilage (*c'*). In the region of the olfactory lobes, the sphenethmoid shows the typical girdle shape with the lateral extension still persisting. Dorsally an infrafrontal (interfrontale ?) extension of the sphenethmoid is also noticed as described in *Hypogeophis* by Marcus, Stimmelmayr and Porsch (1935), and this point is indicated by these authors when they say that (p. 411)

> Die bei *Siphonops* noch das Schadeldach bildende Deckplatte, die bei *Hypogeophis* von den Stirnbeinen verdeckt wird, wurde als Dermethmoidale bezeichnet und der dorsale ebenfalls der male Fortsatz des Processus interfrontalis.

The ophthalmicus profundus branch is enclosed in the dorsolateral wall of the sphenethmoid in posterior sectional views of *Uraeotyphlus*. In



TEXT-FIG. 5.—*Uraeotyphlus narayani* Seshachar.

Transverse section posterior to fig. 4. × 30.

c', nasal cartilages; *csb*, choanenschleimbeutel; *don*, dorsal olfactory nerve; *f*, frontal bone; *inmf*, intermaxillary gland of Fahrenholz; *lcp*, lateral cavum nasale principale; *map*, maxillopalatine; *max$_1$*, medial division of r. maxillaris V; *max$_{2b}$*, branches of *max$_2$*; *mcp*, median cavum nasale principale; *mrt*, m. retractor tentaculi; *ng*, nasal gland; *og*, orbital gland; *op*, r. ophthalmicus profundus V; *op$_1$*, *op$_2$*, branches of r. ophthalmicus profundus; *op$_{1b}$*, branch of *op$_1$*; *pas*, parasphenoid portion of os Basale; *pf$_1$max$_b$*, palatinus facialis *plus* a branch of r. maxillaris V; *pf$_2$*, lateral division of palatinus facialis; *prf*, prefrontal bone; *pv*, prevomer; *sph*, sphenethmoid; *von*, ventral olfactory nerve; *wnn*, wall of Nebennase.

the optic region, the sphenethmoid becomes incomplete midventrally and forms only the ventrolateral boundary for the brain; further in this region the ophthalmicus profundus is not enclosed in a bony canal. The infrafrontal sphenethmoid persists. The foramen opticus (*plus* oculomotorius) appears and the sphenethmoid is noticed only dorsally and ventrally as rounded pieces of bone. However, posteriorly cartilage appears in these two portions representing the orbital (dorsal) and trabecular (ventral) cartilages.

In *Hypogeophis*, the ethmoidal region, which I have designated as the sphenethmoid following de Beer (1937) is composed of an anterior mesethmoid or presphenoid (arising in nasal septum), a dorsal dermethmoid and in the sides by the sphenethmoid (pleurethmoid *plus* sphenorbital) and a preethmoid (in connexion with the prevomer). However, de Beer considers that the sphenethmoid represents the presphenoid and orbitosphenoid bones.

The formation of an eminentia olfactoria (processus conchoides, Sarasins 1890) is characteristic of only some genera of Apoda. In *I. glutinosus* and *I. monochrous* an eminentia olfactoria is formed by the prevomer and sphenethmoid. A ventrolateral extension of the

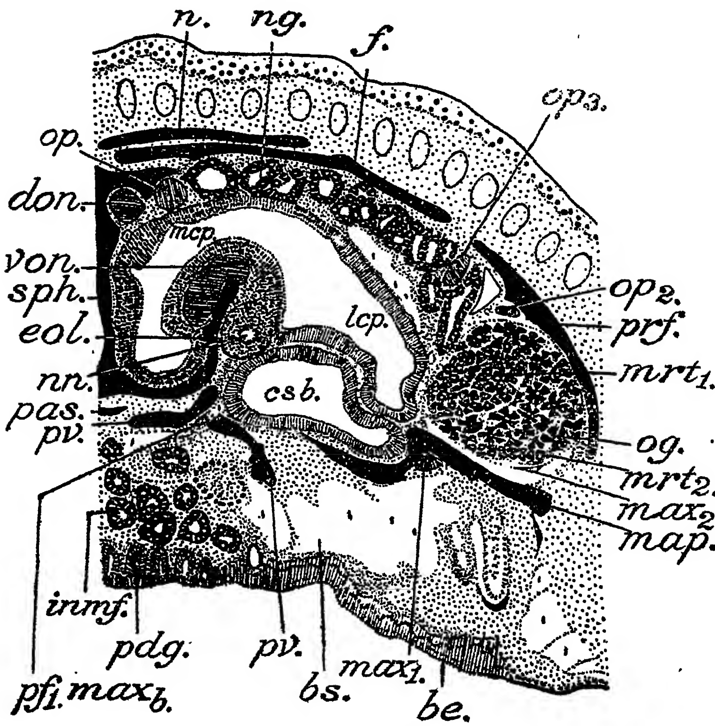
sphenethmoid projects into the nasal sac along with a portion of the prevomer so much so the cavity of the olfactory chamber is divided into a lateral and an inner (median) portion. A similar arrangement is also seen in *Geotrypetes* and *Dermophis* (Norris and Hughes 1918). However, in the latter animal the nasopremaxilla and the prevomer give rise to the elevation in the olfactory chamber anteriorly while in the posterior sections, the prevomer and the sphenethmoid contribute to it. Similarly in the case of *Ichthyophis*, the maxillopalatine sends a small projection on the external aspect of the prevomer. The formation of the eminentia olfactoria is totally wanting in *Herpele*, *Caecilia* and *Hypogeophis* (Wiedersheim 1879 ; Norris and Hughes 1918 ; Marcus, Stimmelmayr and Porsch 1935). In *U. narayani* also an eminentia olfactoria is absent and therefore a lateral chamber of the nasal sac, as described by Sarasins (1890) for *I. glutinosus*, is also absent.[1]

In the investigated examples like *Boulengerula*, the degenerate eye is covered by squamosal while in *Caecilia* and *Herpele* the eye is covered by maxillopalatine and the eye muscles and eminentia olfactoria are absent, whereas in *Ichthyophis*, *Dermophis* and *Geotrypetes* an eminentia olfactoria is developed and the eye is not covered by bone. In *Scolecomorphus* the eye is degenerate and is not covered by any bone, but an eminentia olfactoria is well developed. *U. narayani* forms a good link between *Boulengerula*, *Caecilia* and *Herpele* on the one hand and *Ichthyophis*, *Dermophis* and *Geotrypetes* on the other and it is noticed that the eye in *Uraeotyphlus* is not covered, the eye muscles are well developed with an optic nerve, but an eminentia is absent. It might be thought that there is a correlation between the degeneration of the eye consequent upon covered nature of it as in *Herpele* and *Boulengerula*, etc., and the absence of an eminentia, but the presence of a well developed eye and the absence of an eminentia in *Hypogeophis* and *Uraeotyphlus* and the presence of a degenerate eye and the possession of an eminentia in *Scolecomorphus* (*see* text-fig. 4, *eol.*) rules out any such relation.

The cartilages of the nasal region.—The prenasal prong appears as a thin cartilaginous structure between the premaxillae. In the region where the cartilaginous nasal septum (*see* text-fig. 8, *sn.*) which gives rise to the prong anteriorly widens to give rise to short tectal (*tn.*) and solum (*son.*) cartilages, it is noticed that the lateral sinus of the olfactory chamber (cavum nasale principale) is bounded externally by a crescentic cartilage (*cc.*) from which a short projection is noticed to enter the plica (*pl.*). In sections anterior to the nares, this crescentic cartilage forms a part of the roof and also the floor of the cavum nasale principale. The ventral cartilaginous limb of this in posterior sections lies between the lower limb of the septomaxilla and the premaxilla (text-fig. 1, *c.*) and further posteriorly is seen in between the inner portion of the maxillopalatine and prevomer and joins the bony solum of the sphenethmoid bone. Quite independently of the cartilages mentioned above, there appears a cartilage (*see* text-fig. 9, *c.'*) between the prefrontal and frontal and spreads posteriorly between the maxillopalatine and the sphenethmoidal tectum (text-fig. 3, *c'.*) and fuses with

[1] *See* The olfactory organ and associated glands.

the latter; in other words it is an anterior cartilaginous extension from the tectum.



Text-fig. 4.—*Scolecomorphus uluguruensis* Barbour & Loveridge.

Transverse section showing eminentia olfactoria: ×55.

be., buccal epithelium; *bs.*, blood sinus; *csb.*, "choanenschleimbeutel"; *don.*, dorsal olfactory nerve; *eol.*, eminentia olfactoria; *f.*, frontal bone; *inmf.*, intermaxillary glands of Fahrenholz; *lcp.*, lateral cavum nasale principale; *map.*, maxillopalatine; *max*$_1$., medial division of r. maxillaris V; *max*$_2$., lateral division of r. maxillaris V; *mcp.*, median cavum nasale principale; *mrt*$_1$., *mrt*$_2$., two parts of m. retractor tentaculi; *n.*, nasal bone; *ng.*, nasal gland; *nn.*, "Nebennase"; *og.*, orbital gland; *op.*, *op*$_2$., *op*$_3$., r. ophthalmicus profundus (*op*) and its branches; *pas.*, parasphenoid portion of os basale; *pdg.*, postdental gland; *pf*$_1$*max*$_b$., palatinus facialis *plus* a branch of r. maxillaris V; *prf.*, prefrontal; *pv.*, prevomer; *sph.*, sphenethmoid; *von.*, ventral olfactory nerve.

In the region where the anterior portion of the "Choanenschleimbeutel" (text-fig. 3, *csb.*) is noticed between the two portions of the "Nebennase", a horseshoe-shaped cartilage clasps the choanal chamber; posteriorly a bit of this cartilage (c''.) is noticed dorsally to the maxillopalatine bone and this finally disappears.

Orbito-temporal region.

The frontal (paired).—(text-figs. 3, 9, *f.*) The frontals meet each other in a close suture (Pl. IV, fig. 1) so that the sphenethmoid is not visible externally, a feature also noticed in *Gymnopis* (Peters 1879), *Hypogeophis* (Marcus, Stimmelmayr and Porsch 1935), *Ichthyophis* and *Chthonerpeton*. In *Siphonops* (Wiedersheim 1879) between the naso-premaxilla, the frontals and parietals of either side, the sphenethmoid

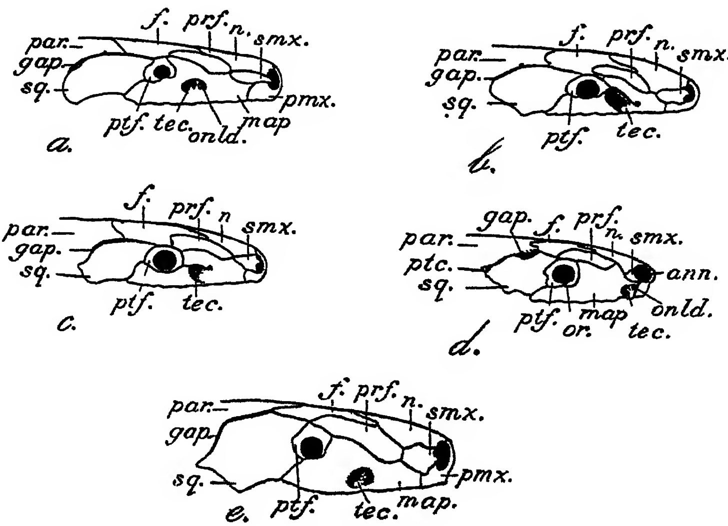
is visible as a diamond-shaped area : in *Herpele squalostomum*, Peters (1879) shows the sphenethmoid in two areas, *viz.*, between the naso-premaxilla and the frontals and between the latter bones and parietals. Parker (1936) who reproduced a figure of the same species of *Herpele* for purposes of comparison with *Idiocranium*, indicates the spheneth-moid as visible externally only between the nasopremaxilla and the frontals ; this probably is a variable feature. In *Scolecomorphus* (Peters 1895) the roofing bones approximate and, therefore, a part of the sphe-nethmoid is not visible externally, a point also confirmed by de Villiers (1938). In *Boulengerula* (Peter 1908). the bone is visible mainly be-tween frontals. From the figures of Norris and Hughes (1918) it can be concluded that the sphenethmoid is visible dorsally owing to the incomplete approximation of the nasopremaxilla and the frontals in *Dermophis* and also in *Herpele.*

The parietal (paired).—(text-fig. 10. *par.*) They appear underneath the frontals and posteriorly form not only the roof but a part (dorsal) of the side, articulating with the os Basale (the pleurosphenoid, prootic and exoccipital parts).

The pre- and post-frontal (paired).— These two bones may be con-sidered together In *Ichthyophis* and *Uraeotyphlus* only these two bones are present, in all other Apoda they are absent, except in *Scole-comorphus* (Peter 1895, 1908) in which only a prefrontal is noticed (text-fig. 4, *prf.*). In the South Indian genera studied by me, the prefrontal (described as Preorbital by J. Müller) is bounded by the nasal and maxillopalatine anterolaterally and posterolaterally by the frontal and prefrontal. In the case of *I. glutinosus*, the figures of Sarasins (1890) show that the anterior tip of the prefrontal reaches the posterior border of the septomaxilla. In some of the skulls that I have examined this is not so, for the prefrontal is separated from the septomaxilla by the juxtaposed portions of the nasal and maxillopalatine. The sectional views of well grown adults of both *I. glutinosus* and *U. narayani* also exhibit the latter feature. A side view (*see* text-figs. 5*a*, 5*c* and 5*e*) depicts the condition enumerated above where the maxillopalatine and the nasal are not separated by the septomaxilla or prefrontal.

The exact contour of the postfrontal differs in individuals. In the case of *I. glutinosus*, Sarasins remarked that the bone was always 'half-moon'-shaped confirming the observation of J. Müller. Wiedersheim (1879) noted that the bone was ring-like normally and the crescentic nature of it was due to injury and Peters (1879) also remarked the same about the bone. In the figure drawn by Nieden (1913, p 3), a ring-like postfrontal (*see* text-fig. 5*c*. *ptf.*) has been shown following Wieder-sheim and Peters. In *U. narayani*, only one type is found, *i.e.*, the circular. In one series of sections of a large animal the postfrontal is ring-like while in another (of a smaller size) it is crescentic with the gap towards the maxillopalatine. In the juvenile specimen of *U. narayani* (9 cm.), which I have studied, it is crescentic. The skulls of large speci-mens that have been prepared by maceration show a ring-like post-frontal. It is therefore abundantly clear that in *U. narayani*, the cres-centic nature of the postfrontal is noticed in smaller animals while in the well grown adults, a ring-like postfrontal is present. In my figures

(Pl. IV, fig. 1 and text-fig. 5*d*) I have shown the bone ring-like. Having examined a large number of skulls of *I. glutinosus*, the crescentic post-



TEXT-FIG. 5.

Ichthyophis glutinosus (Linn.). Skull, lateral aspect.
a. (after Sarasins, 1890) : ×4·5.
b. original : ×4·5.
c. (after Nieden, 1913 modified) : ×4·5.

Uraeotyphlus narayani Seshachar. Skull. lateral aspect, *d.* ×4·5.

Ichthyophis monochrous (Bleek.). Skull, lateral aspect, *e.* ×4·5.

ann., anterior nares; *f*, frontal; *gap.*, fossa between squamosal and parietal; *map.*, maxillopalatine; *n.*, nasal; *onld.*, opening of nasolacrimal duct; *or.*, orbit; *par.*, parietal; *pmx.*, premaxilla; *prf.*, prefrontal; *ptc.*, pteroccipital cavity; *ptf.*, postfrontal; *smx.*, septomaxilla; *sq.*, squamosal; *tec.*, tentacular canal.

frontal is noticed in a majority of them while the presence of a circular one is not uncommon. In my preparations the ring-like postfrontal belongs to one which is easily the biggest among the macerated skulls and since Sarasins (1890) have shown a crescentic postfrontal in an equally large skull the shape of the bone is obviously subject to variation. On the other hand, in *U. narayani*, the shape of the postfrontal is always circular in well grown individuals. Peculiarly there is another feature of variation met with in these South Indian apodan genera to which reference has been made briefly already. In the figures by Sarasins (1890) of *I. glutinosus*, the septomaxilla and prefrontal (text-fig. 5*a*) meet each other; in *I. monochrous* (text-fig. 5*e*) the topographical relationship of bones is exactly like that in *I. glutinosus*. But in the skulls of *I. glutinosus* studied by me, in some where the postfrontal is crescentic the prefrontal and septomaxilla are separated by the extension of nasal and maxillopalatine. The other type where the postfrontal is circular, the close apposition of the prefrontal and septomaxilla is also seen. I do not like to establish any correlation between the

shape of the postfrontal and the nature of approximation of prefrontal and septomaxilla without examining the other species, but it may be remarked that among all the skulls of *I. glutinosus* examined by me not one was noticed to possess a circular postfrontal and with prefrontal and septomaxilla separated from each other. In this connexion, the statement of Peters (1881) based on an examination of two skulls of *Caecilia oxyura* (*U. oxyurus*) that if the prefrontal reached the 'losgelosten nasale' (septomaxilla), it would closely approximate to the condition delineated for *I. glutinosus* is rather significant. This condition, *i e.*, the separated prefrontal and septomaxilla particularly characterises all the skulls of *U. narayani* examined by me.

In *Scolecomorphus kirkii* (Peter 1895, 1908) and in *S. uluguruensis* (de Villiers 1938) there is a separate prefrontal but a postfrontal is absent; in *Hypogeophis* (Marcus, Stimmelmayr and Porsch 1935) a prefrontal appears in the larval stages but in the adult it fuses with the frontal and lachrymal and the composite bone is called a temporal.

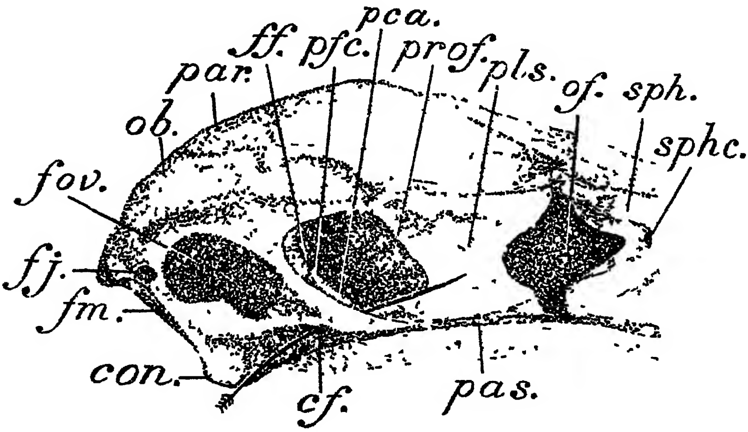
OCCIPITO-AUDITORY REGION.

The os Basale.—Under this term. Sarasins (1890) described the composite skeletal framework formed by the fusion of parasphenoid with its anterior rostrum (Pl. IV, fig. 2, *r.*) (called processus cultriformis in *Hypogeophis*) between the prevomers, basioccipital, supraoccipital and otic ossification and the pleurosphenoid.—the latter forming the lateral wall of the cranium posterior to the optic (*plus* oculomotor) foramen According to Marcus. Stimmelmayr and Porsch (1935) the os Basale is contributed by nine different bones, *viz.*, basi-, pleuro-, supra-, and infra-occipitals, an epiotic, a pleurosphenoid, two parasphenoids and otic capsule.

A similar os Basale is also found in *U. narayani* and on its ventral face, orifices for the carotid artery (Pl. IV, fig. 2, *cf.*) and jugular foramina are located. In the lateral aspect of the cranium (text-fig. 6), the side wall reveals the optic (*plus* oculomotor) (*of.*), prootic (*prof.*) and facial (*ff.*) foramina. Roughly the position of some bones which have fused may be made out. Posterior to the optic (*plus* oculomotor) foramen is the pleurosphenoid bone (*pls.*) which commences from the anterior margin of the prootic foramen. The prootic (*prof.*) and facial (*ff.*) foramina are accommodated in the prootic region. A separate foramen for the oculomotor nerve is not seen, and in those forms where the third nerve is described in the adult, it enters the cranium along with the second nerve through the optic foramen. In the larval stages also there is no separate foramen in the cartilaginous wall and therefore, a pila metoptica is absent. As suggested by de Beer (1937) the cartilaginous wall which separates the optic and trigeminal foramina is a pila antotica produced far anteriorly. The trigeminal (*prof.*) and facial (*ff.*) foramina are separated by a bony bridge,—the prefacial commissure (*pfc.*) both in *Ichthyophis* and *Uraeotyphlus*.

The parasphenoidal portion of the os Basale gives rise to the basipterygoid process (Pl. IV, fig. 2, *bp.*) with which the processus pterygoideus (*ppt.*) of the quadrate is united syndesmotically and since this

joint is identical with the basal articulation found in other Apoda being situated anteriorly to the facial nerve, it must be called a basal joint while in others it is a basal articulation of the cartilaginous facets of the processus pterygoideus and basipterygoid process.



TEXT-FIG. 6.—*Uraeotyphlus narayani* Seshachar.

Side view of cranium showing nerve foramina : ×15.

cf., carotid foramen ; *con.*, condyle ; *ff.*, facial foramen ; *fj.*, jugular foramen ; *fm.*, foramen magnum ; *fov.*, foramen ovale ; *ob.*, os Basale ; *of.*, optic *plus* oculomotor foramen ; *par.*, parietal ; *pas.*, parasphenoid portion of os Basale ; *pca.*, palatine canal ; *pfc.*, prefacial commissure ; *pls.*, pleurosphenoid portion of os Basale ; *prof.*, protoic foramen ; *sph.*, sphenethmoid ; *sphc.*, sphenethmoidal canal for r. ophthalmicus profundus.

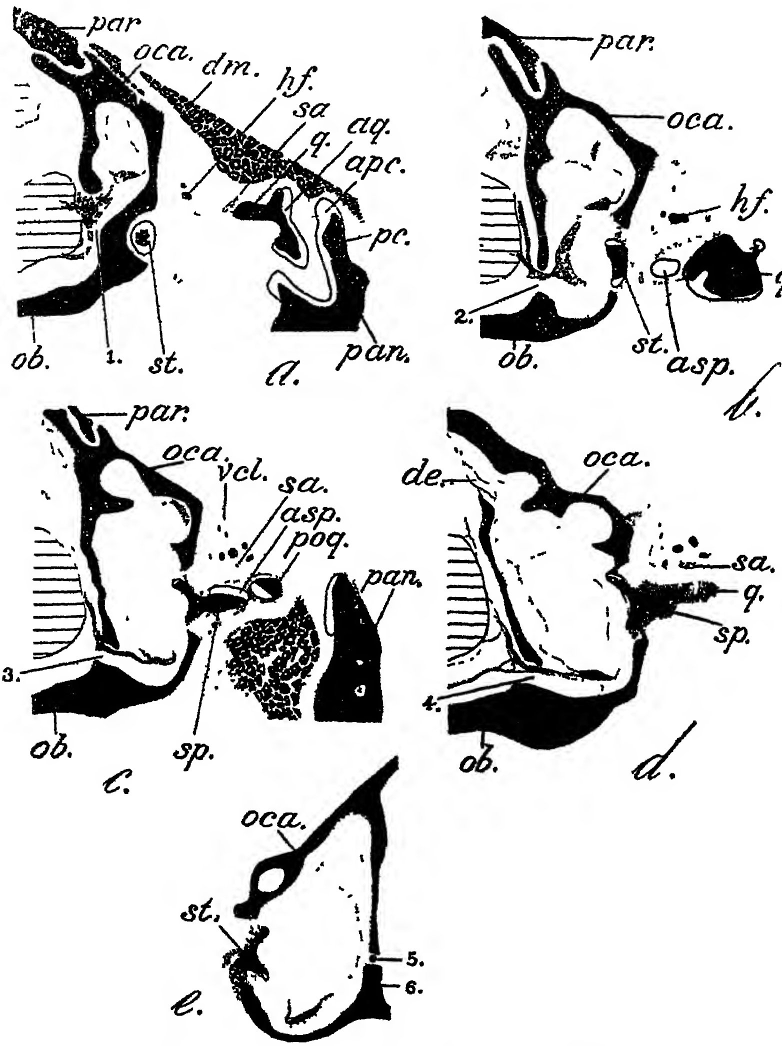
There is a well formed depression (sella turcica), in the os Basale for the accommodation of the pituitary body in *Uraeotyphlus*, *Dermophis*, *Scolecomorphus*, *Boulengerula* and *Herpele*, but in *Ichthyophis* it was not seen.

The stapes (text-fig. 7 *a-d*, *st.*).—(ossified operculum) with its stapedial process (*sp.*) is bony as in other Apoda and invariably the stapedial process articulates by its cartilaginous facet (*asp.*) with a similar facet of the processus oticus. The operculum is, however, stated to be absent by Wiedersheim (1879), Kingsley and Ruddick (1899), Kingsley (1900), M. Fürbringer (1922) and Stadtmüller (1936). The absence of the middle ear is ascribed to a burrowing mode of life by Versluys (1927, 1931). However, in *Scolecomorphus* (de Villiers 1938) there is no stapedial articulation since the stapes is absent (see page 19). In *Dermophis* (de Jager 1939) the stapedial process *unites* with the processus oticus which, however, is not seen in my preparations.

As in *Ichthyophis*, the stapedial artery in *Boulengerula* passes through a canal in the stapes before entering the cranioquadrate passage thus simulating the condition noticed in *Ranodon*, Geckones and mammals.

Marcus (1933) has pointed out that the stapes in *Hypogeophis* is in blastematous continuity with the hyoid in early stages of development and therefore it is a hyoid derivative. If this is proved for other

apodan genera also. then the suspension of the pterygoquadrate or quadrate is hyostylic.



TEXT-FIG. 7.—*Uraeotyphlus narayani* Seshachar.

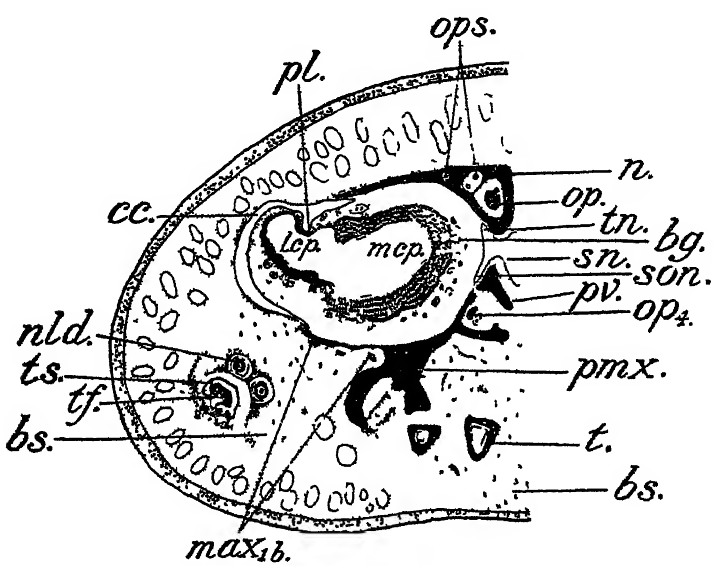
a—e., consecutive transverse sections in the auditory region: ×22.

apc., articular facet of the processus condyloides; *aq.*, articular facet of the quadrate; *asp.*, articular process of stapes; *de.*, ductus endolymphaticus; *dm.*, M. depressor mandibulae; *hf.*, r. hyomandibularis facialis; *ob.*, os Basale; *oca.*, otic capsule; *pan.*, pseudoangular; *par.*, parietal; *pc.*, processus condyloides; *poq.*, processus oticus of quadrate; *q.*, quadrate; *sa.*, stapedial artery; *sp.*, stapedial process; *st.*, stapes; *vcl.*, vena capitis lateralis; *1.*, auditory orifice for the utricular nerve; *2, 3, 4, 5, 6.*, auditory orifices for the saccular nerves.

THE UPPER JAW, PALATE AND SUSPENSORIUM.

The premaxilla (paired).—The first bony structure one meets with in the sectional views of the anterior narial region is the premaxilla

(Pl. IV, figs. 1, 2 and text-fig. 8, *pmx.*). The premaxilla of either side is noticed to be pierced by blood vessels and branches of ophthalmicus profundus nerve. It is also seen that there is an oval cartilage of the sphenethmoid between the premaxillae of either side and in embryos, this cartilage projects as the prenasal prong (Peter 1898, de Beer 1937). Posteriorly, the premaxilla forms partly the internal boundary of the olfactory organ and a principal branch of ophthalmicus profundus (text-fig. 8, op_4) and a ramulus from the median branch of maxillary V run within it before gaining exit. In the region where the anterior portion of the "Nebennase"[1] is met with, the premaxilla disappears from sections.



TEXT-FIG. 8.—*Uraeotyphlus narayani* Seshachar.

Transverse section anterior to fig. 1: × 33.

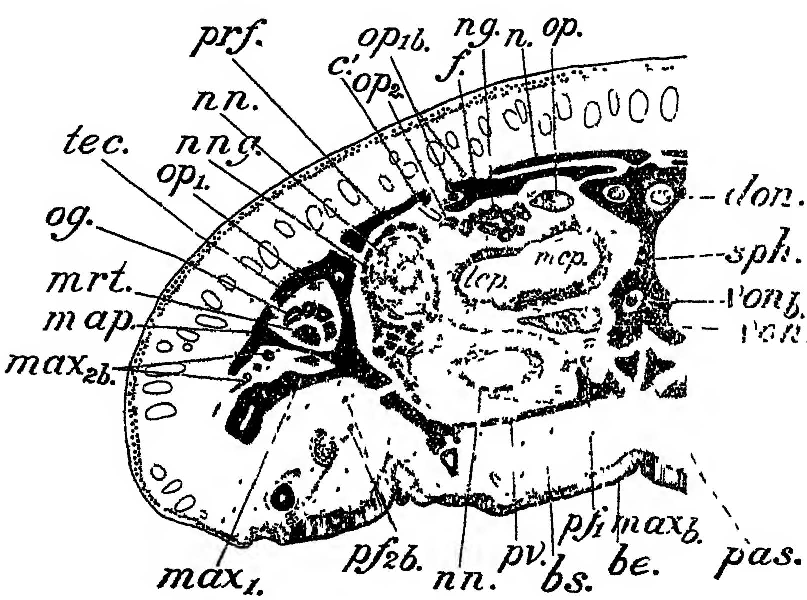
bg., Bowman's gland; *bs.*, blood sinus; *cc.*, crescentic cartilage; *lcp.*, lateral cavum nasale principale; *mcp.*, median cavum nasale principale; *max$_{1b}$.*, branches of max$_1$; *n.*, nasal; *nld.*, nasolacrimal duct; *op.*, *op$_4$.*, r. ophthalmicus profundus and branch respectively; *ops.*, branches of *op* to skin; *pl.*, plica; *pmx.*, premaxilla; *pv.*, prevomer; *son.*, solum nasi; *sn.*, septum nasi; *t.*, tooth; *tf.*, tentacular fold; *tn.*, tectum nasi; *ts.*, tentacular sac.

The fusion of the premaxilla with the nasal and septomaxilla to form a nasopremaxilla is a common feature of the apodan genera. In *Hypogeophis*, *Caecilia*, *Herpele*, *Gymnopis*, *Chthonerpeton*, *Siphonops*, *Boulengerula* (Peter 1908), *Dermophis* (Norris and Hughes 1918, de Jager 1939), *Idiocranium* (Parker 1936) a fused nasopremaxilla is noticed. In *I. glutinosus*, *I. monochrous*, *U. narayani* and *Scolecomorphus* (Peter 1908) the nasals, premaxilla and septomaxilla are always separate though de Beer (1937) points out that these bones fuse in *I. glutinosus*.

The maxillopalatine (paired).—The anteriormost part of the maxillopalatine is met with in sections behind the anterior nares (Pl. IV,

[1] *See* The olfactory organ and associated glands.

figs. 1, 2 and text-fig. 1, *map.*). In the region where the two nasolacrimal ducts enter into the "Nebennase" the outer portion of the maxillopalatine is seen as a horseshoe-shaped structure enclosing the "Nebennase". In the choanal region the lateral branch of the palatinus facialis passes through a foramen in this bone and runs ventrally to it. Further posteriorly where the tentacular canal (text-fig. 9, *tec.*) in the maxillopalatine (*map.*) is noticed dorsally, the lateral (max_{2b}) and medial (max_1) maxillary branches run ventrally in the bone separated from each other. Dorsally to the tentacular canal, the ophthalmicus profundus branch (op_2) runs in the maxillopalatine. In the optic region, the two passages for the maxillary ramuli are lost and postoptically, it is noticed that the anterior end of the pterygoid articulates with the posterior tip of the maxillopalatine by means of connective tissue (*see* text-fig. 10, *pt.*, *map.*).



TEXT-FIG. 9.—*Uraeotyphlus narayani* Seshachar.

Transverse section posterior to fig. 1 : ×33.

be., buccal epithelium ; *bs.*, blood sinus ; *c'.*, nasal cartilage ; *don.*, dorsal olfactory nerve ; *f.*, frontal ; *lcp.*, lateral cavum nasale principale ; *map.*, maxillopalatine ; max_1., medial division of r. maxillaris V ; max_{2b}., branches of max_2 ; *mcp.*, median cavum nasale principale ; *mrt.*, M. retractor tentaculi ; *n.*, nasal ; *ng.*, nasal gland ; *nn.*, "Nebennase" ; *nng.*, glands of "Nebennase" ; *og.*, orbital gland ; *op.*, op_1, op_{1b}, op_2., r. ophthalmicus profundus and branches ; *pas.*, parasphenoid portion of os Basale ; pf_1max_b., palatinus facialis *plus* a branch of r. maxillaris V ; pf_{2b}., branch of the lateral division of palatinus facialis ; *prf.*, prefrontal ; *pv.*, prevomer ; *sph.*, sphenethmoid ; *tec.*, tentacular canal ; *von.*, ventral olfactory nerve ; von_b., branch of *von.*

In *Boulengerula*. it is noticed by de Villiers (1938) that the suture between the posterior portion of the premaxilla of the nasopremaxilla and the maxillopalatine is lost and therefore the maxillopalatine also fuses with the anterior bones.—an instance of further consolidation of the bones of the maxillary segment.

In *Hypogeophis* (Marcus, Stimmelmayr and Porsch 1935) the maxillopalatine is formed by the fusion of maxilla, palatine and lachrymal and probably in *Ichthyophis*, the first two go to form the composite bone.

Two rows of teeth can be distinguished ; an outer and an inner. While the outer row is borne upon the premaxilla and the maxillopalatine, the inner row is carried by the prevomer and the maxillopalatine. Between the two rows of teeth, there is a large interdental area and glands occupy this region and these are described separately (*see* The glands of buccal cavity). However, the second row of maxillopalatine teeth may form an incomplete row. In *Scolecomorphus* and *Boulengerula* (Peter 1908) the teeth of the second row are absent near the choana, while anteriorly and posteriorly the prevomer and maxillopalatine are dentigerous.

The pterygoid (paired).—This bone (Pl. IV, fig. 2 and text-fig. 10, *pt.*) which is situated between the posterolateral aspect of the maxillopalatine and the basipterygoid process of the os Basale, does not fuse with the quadrate to form a pterygoquadrate in *I. glutinosus*, *I. monochrous* and *U. narayani*. The pterygoid (Pl. IV, fig. 2, *pt.*) and the os Basale are separated by a large vacuity,—the mediopalatinal cavity (*mpc.*) which is filled with connective tissue in the living animal. In posterior sectional views where the articular facet of the os Basale (basipterygoid process) is met with, the anterior portion of the processus pterygoideus of the quadrate is noticed dorsally to the pterygoid bone. In *Chthonerpeton* (Peters 1879), *Ichthyophis* (Sarasins 1890), *Idiocranium* (Parker 1936) and in *I. monochrous* and *Uraeotyphlus*[1] the pterygoid is an independent bone. In the other genera investigated a pterygoquadrate has been described, this is surmised to be formed by the fusion of the pterygoid and quadrate, though developmentally it is not substantiated. In *Boulengerula* (Peter 1908, de Villiers 1938), *Scolecomorphus* (de Villiers 1938), *Dermophis* (de Jager 1939), and also in *Herpele*, a pterygoquadrate is seen. Wiedersheim (1879) was not able to discover a pterygoid in *Siphonops*, *Chthonerpeton*, *Hypogeophis rostratus* and *Caecilia* and he referred the "doubtful bones" in between the maxillopalatine and the processus pterygoideus as Jugale (?) or postpalatine (?). Luther (1914) in his figures 4B and C shows a well marked pterygoid in *Siphonops* (dentigerous) while in *Caecilia*, a posterior portion of the maxillopalatine is shown as pterygoid. It is just possible that the processus pterygoideus of the pterygoquadrate reaches the maxillopalatine with no definite bone in between. In *Hypogeophis alternans* an independent quadrate or the formation of a pterygoquadrate is described by Marcus, Winsauer and Hueber (1933) and is depicted in their figures 3, 19 and 23.

The prevomer (paired).—The prevomer[2] (Pl. IV, fig. 2 and text-figs. 1, 3, 8, 9, *pv.*) which forms the roof of the palate anteriorly is bounded by the premaxilla or the premaxillary part of the nasopremaxilla anteriorly, the maxillopalatine laterally and the parasphenoidal rostrum

[1] Peter (1908) was not able to discover the nature of the pterygoid (united with quadrate or free) in *Uraeotyphlus* and *Scolecomorphus*.

[2] Parrington and Westoll (1939) remark that the term prevomer is synonymous with vomer and must be dropped.

of the os Basale mesially. This rostrum may or may not be visible externally in macerated skulls. In *Ichthyophis*, the prevomers of either side meet each other mesially, and only a very small portion of the rostrum is seen; the internal portion lies between the prevomers and the base of the sphenethmoid. In *U. narayani*, the prevomers are wide apart and between these bones the rostrum is seen. In one specimen of *U. narayani* whose sections are figured, the rostrum is double, but in the juvenile one and the other adults there is only a single one.

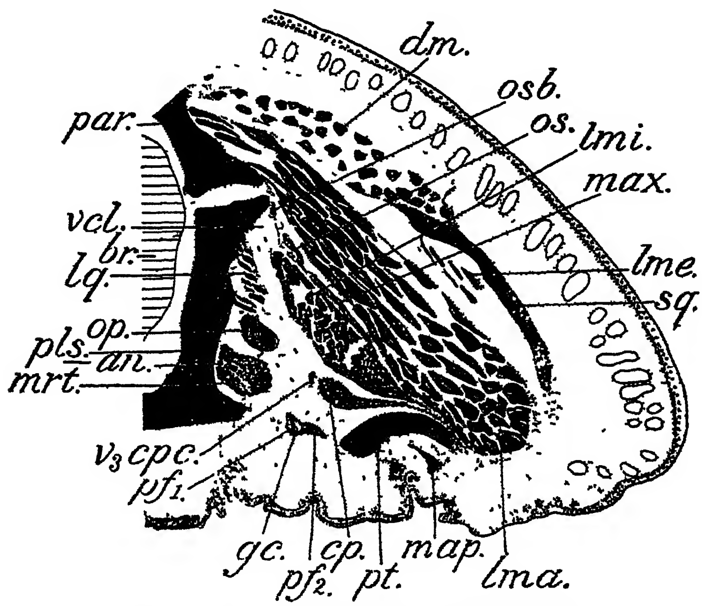
The second row of teeth belonging to the upper jaw is arranged as an arc of a circle on each prevomer. In the majority of cases the prevomer forms the anteromedian boundary of the choana (*Ichthyophis*, *Uraeotyphlus*, *Scolecomorphus*, etc.), while in *Dermophis* (*D. thomensis*, *D. seychellensis*, *D. mexicanus*, Parker 1936) and *Boulengerula* (Peter 1908) the prevomer lies far distant from the choanal opening. It has already been remarked that the prevomer contributes to the formation along with a limb of the sphenethmoid of an eminentia olfactoria, as in *I. glutinosus*. *I. monochrous*, *Dermophis* (Norris and Hughes 1918). *Geotrypetes* and *Scolecomorphus* (*see* Wiedersheim 1879, Figs. 32-34 and 37-40). The bone is pierced in *Uraeotyphlus* by the ventral ramulus of the ophthalmicus profundus nerve (op_4.) anteriorly and posteriorly by the palatinus facialis (pf_1max_b.) as in other Apoda. In the choanal region the prevomer articulates with the rostrum referred to above and the bone disappears a few sections posteriorly to the choana.

The squamosal (paired).—(*Paraquadrate* Gaupp., Peter., Marcus, Winsauer and Haeber., Marcus, Stimmelmayr and Porsch., *Jugale* Sarasins., *Squamosojugale* Peter., Peters).

It has already been remarked that the stegokrotaphic nature or zygokrotaphy of squamosal and parietal is utilised for purposes of taxonomy and the presence of a large gap between the parietal and squamosal in *Uraeotyphlus* (Pl. IV, fig. 1, *gap.*) separates it from its South Indian congener *Ichthyophis*. However, in *Ichthyophis*, a thin cleft is figured by Sarasins between the above named bones: but Wiedersheim (1879) does not show any cleft thereby making it a typically stegokrotaphic cranium. Peter (1908) refers to this feature as probably a variation. This is not an individual variation or due to differences in growth as Peters (1881) imagined it to be, for, having studied a large number of skulls of *Ichthyophis* and *Uraeotyphlus*, I notice a thin cleft in the former and a big one in *Uraeotyphlus*, and therefore the presence or absence of a cleft is certainly comparative.

In sectional views, the squamosal is noticed posteriorly to the postfrontal and is disposed laterally to the frontal and parietal, and in anterior sections dorsally to the maxillopalatine. In the posterior region of the optic (*plus* oculomotor) foramen the brain is covered over by the parietal and on the sides the anterior portion of the pleurosphenoid encloses the reminiscent orbital cartilage; the floor is formed by the os Basale (parasphenoid portion). Between the side wall of the cranium and the squamosal (Pl. IV, fig. 2 and text-fig. 10, *sq.*) in the lower temporal fossa (*ltf.*), the MM. levator mandibular anterior (*lma.*), levator mandibular externus (*lme.*), levator mandibulae internus (*cp.*, *lmi.*), the ophthalmicus profundus (*op.*) and maxillary (*max.*) branches of

the trigeminal nerve and the head vein (*vcl.*) are noticed. Posteriorly the squamosal gives rise to a shelf-like projection towards the cranium (seen only in a few sections) free from any muscle insertions as in *Boulengerula*. Where the quadrate (Pl. IV, fig. 2, *q.*) appears as a bone closely applied to the inner face of the squamosal (*sq.*) separated by a thin connective tissue lamella, the insertion of the fibres of M. levator mandibulae externus is noticed on the former bone: the apposition of the bones persists in a large number of sections, and posteriorly to the trigeminal foramen, the squamosal disappears.



Text-fig. 10.—*Uraeotyphlus narayani* Seshachar.

Transverse section in the squamosal region: ×33.

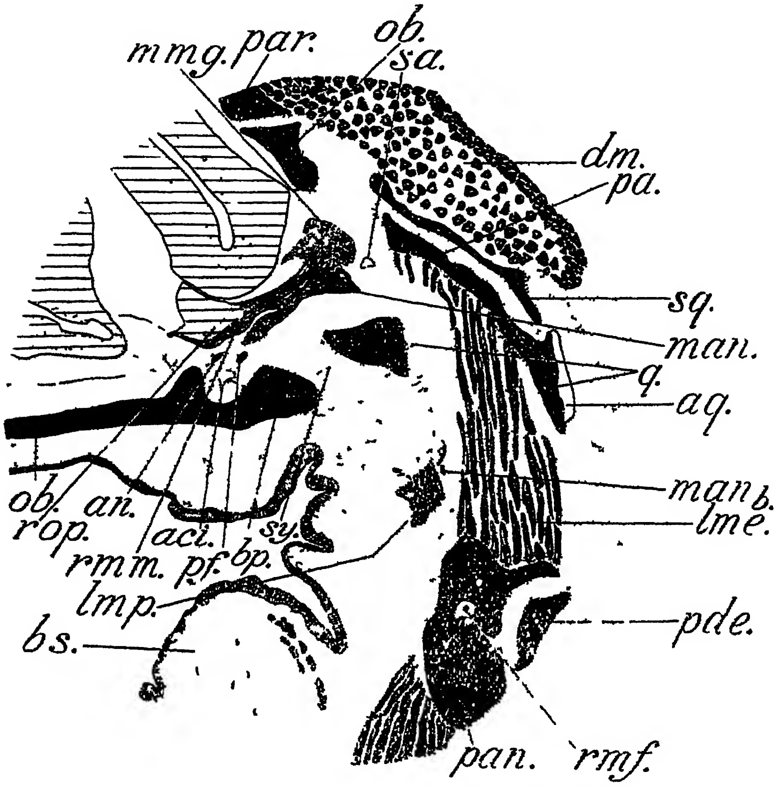
an., abducens nerve; *br.*, brain; *cp.*, "Caput preorbitale" of M. l. m. internus; *dm.*, M. depressor mandibulae; *gc.*, ganglion cell; *lma.*, M. levator mandibulae anterior; *lme.*, M. levator mandibulae externus; *lmi.*, M. levator mandibulae internus; *lq.*, M. levator quadrati; *map.*, maxillopalatine; *max.*, r. maxillaris V; *mrt.*, M. retractor tentaculi; *op.*, r. ophthalmicus profundus V; *os.*, r. ophthalmicus superficialis VII; *osb.*, branch of r. ophthalmicus superficialis; *par.*, parietal; *pls.*, pleurosphenoid portion of os Basale; pf_1, pf_2, median and lateral divisions of r. palatinus facialis respectively; *pt.*, pterygoid bone; *sq.*, squamosal; *vcl.*, vena capitis lateralis; $v_3cpc.$, branch of r. mandibularis V to "Caput preorbitale" and M. compressor orbitalis.

[In figures 14, 15, 18, 20-25 and 28 Norris and Hughes (1918) label a bone in a precise topographical position of the squamosal as 'post-frontal'. The disposition of the bone and the muscular attachment conclusively prove when compared with other forms that it is a squamosal and not a post-frontal, for notice in figure 28, the post-frontal lying externally to the anterior portion of the 'pterygoquadrate', an anomalous position, and moreover, in the species examined by them, a post-frontal is absent.]

The quadrate (paired) or Suspensorium of Sarasins.

On the inner aspect of the squamosal appears the anterior portion of the quadrate (Pl. IV, fig. 2, *q.*) as an elongated bone separated by

some connective tissue. We can distinguish three processes given off anteriorly from the quadrate bone, a processus ascendens (processus



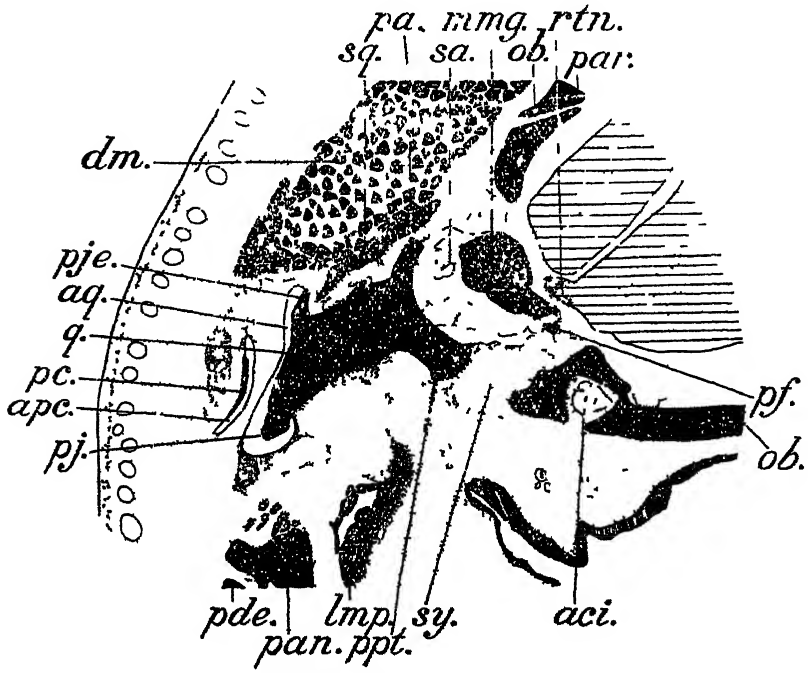
TEXT FIG. 11.—*Uraeotyphlus narayani* Seshachar.

Transverse section in the region of gasserian ganglion : ×33

aci., arteria carotis interna ; *an.*, abducens nerve, *aq.*, articular facet of the quadrate ; *bp.*, basipterygoid process ; *bs*, blood sinus, *dm*, M depressor mandibulae ; *lme.*, M. levator mandibulae externus, *lmp*, M levator mandibulae posterior, *man.*, r. mandibularis V ; *manb.*, branch of r. mandibularis V, *mmg*, maxillomandibular part of gasserian ganglion, *ob*, os Basale, *pa*, processus ascendens ; *pan*, pseudoangular ; *par.*, parietal ; *pde.*, pseudodentary, *pf*, r palatinus facialis, *q*, quadrate, *rmf*, ramulus mandibularis internus facialis (chorda tympani) ; *rmm.*, root of maxillomandibular nerve, *rop.*, root of ophthalmicus profundus nerve, *sa*. stapedial artery, *sq*, squamosal ; *sy.*, syndesmotic connection.

squamosus, Sarasins 1890) (Pl. IV, fig. 2 and text-figs 11, 12, *pa.*), a processus pterygoideus (Pl. IV, fig. 2 and text-fig. 12, *ppt.*) which articulates with the basipterygoid process (Pl. IV, fig. 2 and text-figs. 11, 12 : *bp.*) of the os Basale by connective tissue (syndesmosis) (*sy.*), and a processus jugalis (text-fig. 12, *pj.*). Posteriorly, the quadrate gives rise to a fourth process,—the processus oticus (processus columellaris) (Pl. IV, fig. 2 : *see* also text-fig 7*b*, *poq.*) whose cartilaginous tip articulates with the cartilaginous portion of the stapedial process. From the external aspect of the short processus jugalis (text-fig. 12, *pj.*), a process is given off which articulates with the lower tip of the squamosal *sq.*) by means of connective tissue. I have called this the processus

jugalis externus (text-fig. 12, *pje*) In the region of the articulation of the lower jaw, the quadrate bears a processus articularis (Pl IV, fig. 2 and text-fig 12 *see* also text-fig. 7*a*., *aq*.) with which the pseudo-angulare articulates.



TEXT-FIG. 12.—*Uraeotyphlus narayani* Seshachar.

Transverse section in the region of the Quadrate : ×33.

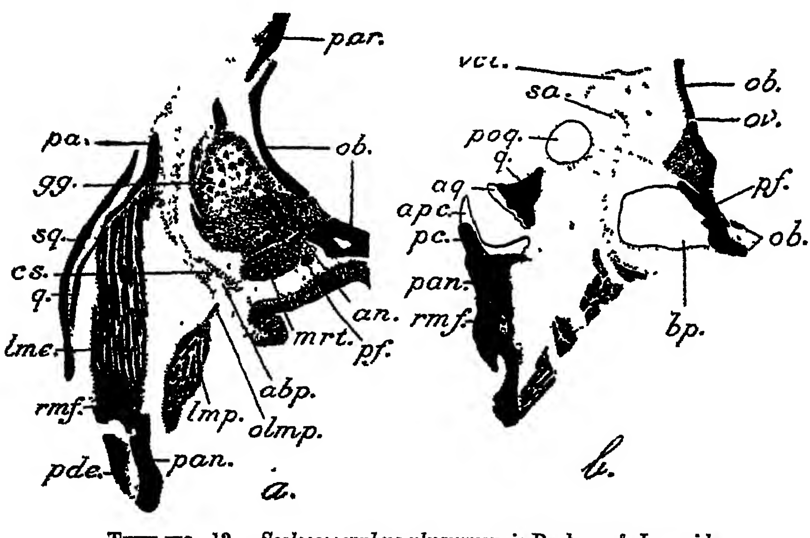
aci., arteria carotis interna; *apc*, articular facet for the processus condyloides; *aq.*, articular facet of the quadrate; *dm*, M. depressor mandibulae; *lmp.*, M levator mandibulae posterior; *mmg*, maxillomandibular part of gasserian ganglion, *ob.*, os Basale; *pa*, processus ascendens; *pan*, pseudoangular; *par*, parietal; *pc*, processus condyloides; *pde*, pseudodentary: *pf*, r. palatinus facialis; *pj.*, processus jugalis; *pje*, processus jugalis externus; *ppt.*, processus pterygoideus; *q.*, quadrate; *rtn.*, root of trigeminal nerve; *sa.*, stapedial artery; *sq*, squamosal; *sy.*, syndesmotic connection.

In *Ichthyophis*, the processus jugalis is longer than in *Uraeotyphlus* and Peter (1898) discovered a quadratojugal bone in it.

The articulation of the processus pterygoideus of the quadrate (or the pterygoquadrate where the pterygoid is not discoverable as an independent bone) with the basipterygoid process of the os Basale is a characteristic feature of Apoda. In *Ichthyophis* and *Uraeotyphlus* the articulation is by syndesmosis; in the former even in the larval condition, the quadrate does not develop a basal process[1] and therefore the quadrate is syndesmotically connected with the basitrabecular or basipterygoid process. This may apply also to *Uraeotyphlus*. In other forms that have been studied, *viz.*, *Dermophis* (Norris and Hughes

[1] However, Edgeworth (1925, p. 235) mentions in his table that 'basal process' forms a joint with the 'basal plate' in *Ichthyophis* and Peter (1898) also referred to a rudimentary processus basalis palatoquadrati.

1918, de Jager 1938, 1939), *Herpele* (Norris and Hughes 1918), *Boulengerula* (de Villiers 1936) the articulation is by the cartilaginous facets of the basipterygoid process and the processus pterygoideus of the quadrate. A basal process has been described in a *Siphonops brazieliense* larva (7 cm. long), which is continuous with the basitrabecular process by Edgeworth (1925, 1935) but in the same sized larva, Goodrich (1930, Fig. 509) shows a joint. In *Hypogeophis* also (Marcus, Stimmelmayr and Porsch 1935) a basal process of the quadrate is formed which develops into the adult palatobasal articulation with the basipterygoid process. In *Scolecomorphus* (de Villiers 1938, p. 9) it is noted that "Although *Scolecomorphus* lacks a quadratostapedial articulation, it retains the pterygoquadratobasal one which is situated much more dorsally and much more closely to the side of the neurocranium than in *Boulengerula*", but again on page 11, the author states that "There is of course just a possibility of *Scolecomorphus* being neotenic in which case the absence of basopterygoquadrate and of a loose attachment of the outer wall of the otic capsule may not be due to degeneration at all". My own sections show that there is a connective tissue strand arising from the processus ascendens (text-fig. 13*a*, *pa.*) and proceeding towards the anterior portion of the basipterygoid process where the ligament of the M. l. m. posterior (*lmp.*) is also inserted. However, in posterior sections (text-fig. 13*b*) arising from the processus pterygoi-



TEXT-FIG. 13.—*Scolecomorphus uluguruensis* Barbour & Loveridge.

a. Transverse section in the suspensorial region: ×*ca.* 40.

b. Transverse section posterior to *a*: ×*ca.* 40.

abp., anterior face of the basipteryogoid process; *an.*, abducens nerve; *apc.*, articular facet of the processus condyloides; *aq.*, articular facet of the quadrate; *bp.*, basipterygoid process; *cs.*, connective tissue strand from ascending to basipterygoid process; *gg.*, gasserian ganglion; *lme.*, M. levator mandibulae externus; *lmp.*, M. levator mandibulae posterior; *mrt.*, M. retractor tentaculi; *ob.*, os Basale; *olmp.*, origin of M. levator mandibulae posterior; *ov.*, orifice for a branch of vena capitis lateralis in the wall; *pa.*, processus ascendens; *pan.*, pseudoangular; *par.*, parietal; *pc.*, processus condyloides; *pde.*, pseudodentary; *pf.*, r. palatinus facialis; *poq.*, processus oticus of quadrate; *q.*, quadrate; *rmf.*, ramulus mandibularis internus facialis; *sa.*, stapedial artery; *sq.*, squamosal; *vcl.*, vena capitis lateralis.

deus is a cartilaginous facet with which a similar facet of the basipterygoid process (*bp.*) articulates as in *Boulengerula.*

The processus oticus (processus columellaris of Marcus, Winsauer and Hueber 1933) articulation of the quadrate with the stapedial process is another characteristic feature of Apoda. In *Ichthyophis*, *Uraeotyphlus* (Pl. IV, fig. 2, *poq.*), *Boulengerula*, (de Villiers 1938) and in *Herpele*, it is present : in *Siphonops* and *Caecilia* a rudimentary one is recorded (Stadtmüller 1936) while in *Scolecomorphus* (de Villiers 1938) it is absent along with the stapes.[1] In *Dermophis* (de Jager 1939) the processus oticus palatoquadrati is fused with the stapedial style and according to her this loss of quadrato-stapedial kinesis has taken place within recent times. It is of interest to note that in the case of *Hypogeophis* larva (Marcus, Stimmelmayr and Porsch 1935) the processus oticus of the quadrate enters into a temporary fusion with the stapedial process. In *Ichthyophis* embryo (Goodrich 1930) there is a processus oticus (rudimentary according to Stadtmüller 1936) which does not establish any connection dorsally while in *Siphonops* larva (Goodrich 1930, Fig. 509) the otic process establishes contact with the auditory capsule. Edgeworth (1925, 1935) however, differs from Goodrich ; he does not find an otic process in his larva of *Ichthyophis* measuring 2·85 cm, but his Fig. 88 of *Siphonops* larva resembles exactly the reconstructed figure 509 of Goodrich where the otic process of the latter author corresponds with the processus ascendens articulating by means of a joint with the pleurosphenoid region. Incidentally, it may be remarked here that the bone labelled by Goodrich in his figure as 'f' (frontal) should be read as parietal.

A brief reference may be made to the connection of the processus ascendens with the orbital cartilage (taenia marginalis). The connection of the processus ascendens with the orbital cartilage has been recorded by Winslow (1898) and Edgeworth (1925, 1935) in *I. glutinosus* embryos, but Peter (1898) who also studied early embryonic stages does not. While Edgeworth records the size of the embryo (2·85 cm.) the other two authors do not ; Edgeworth, however, mentions that his embryo is slightly smaller than the one modelled by Peter. There is just a chance that the processus ascendens connection might have been formed previously and lost in Peter's stage. De Jager (1939*a*) refers to a similar connection (between pleurosphenoid and processus ascendens cartilage) in a 11 cm. larva of *I. glutinosus*, and further remarks that had Peter examined a similar stage he would have discovered it since he did not study stages between 10 and 16 cm. in length, while Stadtmüller (1936) mentions only a partial connection in a 10 cm. larva of *I. glutinosus*. When I referred this point to Prof. Goodrich he informed me that this difference in the behaviour of the processus ascendens connection may be due to the fact that the authors were examining embryos of different species of *Ichthyophis*. This is not so, for, both Winslow and Peter secured their material from Dr. F. Sarasin, and unless it be that Sarasin's collection itself consisted of two races, it is difficult to reconcile the observations of Edgeworth and Winslow on the one hand and Peter on the other. De Jager's account may not

[1] Though de Villiers refers in the text to the absence of a stapes yet in his figure 4 (p. 14), a stapes is indicated.

be taken into consideration since she describes it in a larval form and also since the time of appearance of these cartilaginous structures varies. I have not been able to secure early embryonic stages, but in the stages examined by me of *I. glutinosus*, no connection was noticed. Therefore it may be that as suggested above, Edgeworth and Winslow were examining a stage where a connection is present and Peter, a slightly older one (as recorded by Edgeworth) where the connection is lost or if not, it is a case of variation.

THE GLANDS OF THE BUCCAL CAVITY.

Recently two memoirs have been published on buccal cavity glands; one on Anura (Müller 1932) and another on Urodela (Seifert 1932). Leydig (1868) and Wiedersheim (1879) described the glands of the buccal cavity of some apodan genera. In *Ichthyophis glutinosus*, Sarasins (1890) described a set of glands between the two rows of teeth in the upper jaw and a set behind the second row of teeth. Both these are designated by them as the palatal glands (Gaumendrüse). Mang (1935) working on *Hypogeophis* labelled the glands present in between the dental rows as the "interdental" glands while those behind the second row of teeth as the "intermaxillary" glands. But Fahrenholz[1] (1934) described in *Uraeotyphlus menoni*, a few glands distributed almost mediolongitudinally starting slightly anteriorly to the choana as the intermaxillary glands comparable with those found in Anura and Urodela; this set is obviously in addition to the set found in between the teeth rows and that behind them. He did not refer to the "Gaumendrüse" in *U. menoni* but suggested that an examination of the "zwischenkieferdrüse" in other apodan genera would be very desirable. In the case of *I. monochrous* and also in *I. glutinosus*, the intermaxillary glands as described by Fahrenholz for *Uraeotyphlus* are absent (Mahadevan 1936). In *U. narayani* (text-fig. 3, *inmf.*) and *U. menoni*, an extra set is added on in the palate which opens into the buccal cavity in a median groove as described in some Urodela (Seifert 1932). Mang (1935) however, did not refer to this gland in *Hypogeophis* and obviously it is absent and as already pointed out, the second set corresponding to the "Gaumendrüse" of Sarasins, is labelled by him in *Hypogeophis* as intermaxillary glands. The nomenclature I have adopted is as follows:

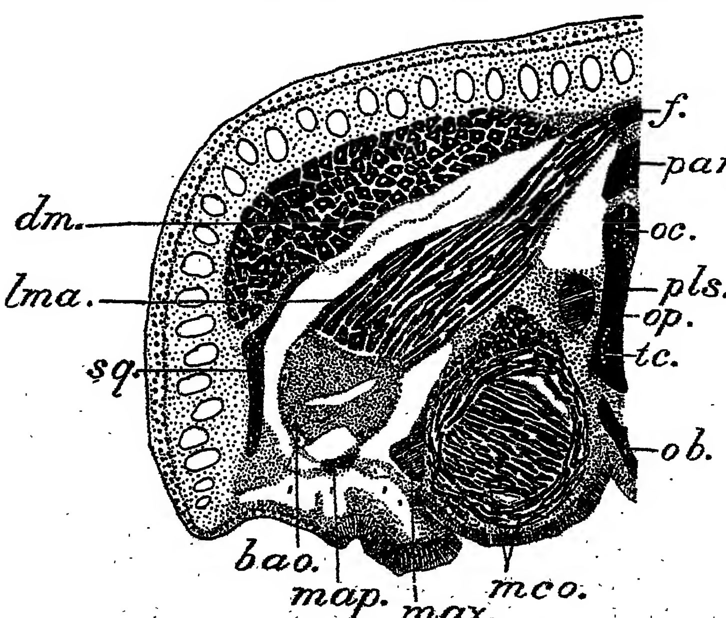
I. glutinosus (Sarasins 1890).	Gaumendrüse 1. between teeth rows, upper jaw.	Gaumendrüse 2. behind second teeth row.	No intermaxillary of Fahrenholz.
I. monochrous (Mahadevan 1936).	Interdental glands	Intermaxillary glands	Absent.
U. menoni (Fahrenholz 1934).	No reference	No reference	Present.
U. narayani (Ramaswami).	Interdental glands	Postdental glands	Present.
H. ochrocephala	Ditto	Ditto	Absent.
S. uluguruensis	Ditto	Ditto	Present; differs from that in *Uraeotyphlus*.
B. boulengeri	Ditto	Ditto	Absent.
D. gregorii	Ditto	Ditto	Absent.

[1] Fahrenholz does not unfortunately mention the source of his material, and if it was from South India, it is just possible that both of us have been dealing with the more commonly occurring species, *U. narayani* which for a long time the authorities of the Biological Supplies, Kottayam, S. India were supplying under the name of *U. menoni*.

Both the interdental and postdental glands resemble each other in histological details and the name suggested therefore is more for topographical convenience than for histological differentiation. However, the intermaxillary glands of *U. menoni* and *U. narayani* differ considerably from the other sets described above. A comparision of the interdental or postdental of *I. monochrous* or *U. narayani* (Pl. VI, fig. 1, *indg.*, *pdg.*) with the intermaxillary of *U. narayani* (*see* text-fig. 3, *inmf.*) reveals at once the points of difference. As in *U. menoni*, each gland in *U. narayani* also is composed of single layered glandular epithelium and opens into the buccal cavity by a convoluted duct. While in the younger specimen examined the duct is short and opens directly from the gland above into the mouth, in aged individuals the gland is enlarged and the duct follows an oblique course.

In *Scolecomorphus* (Pl. V, fig. 4 and text-fig. 4, *inmf.*) a well developed set of glands is present between the sphenethmoid region and the postdental glands (*pdg.*) resembling the dorsal glands (*ng.*). These open into the buccal cavity posteriorly and are topographically comparable with the intermaxillary glands of Fahrenholz, and I have therefore designated them as the intermaxillary glands.

The true palatal glands (*Palatinaldrüse* Mang 1935, *Rachendrüse* of Anura, Oppel 1900) described as occurring behind the choanae in *Hypogeophis* are absent in *I. glutinosus, I. monochrous* and *U. narayani.* No reference is made to these glands in *U. menoni* by Fahrenholz (1934).



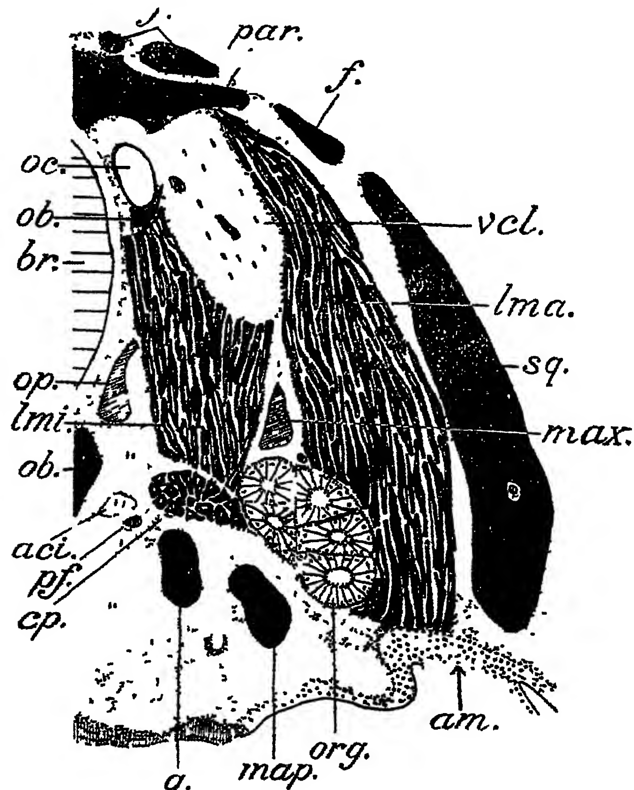
Text-fig. 14.—*Scolecomorphus uluguruensis* Barbour & Loveridge.

Transverse section showing Bursa angularis oris: ×55.

bao., Bursa angularis oris; *dm.*, M. depressor mandibulae; *f.*, frontal; *lma.*, M. levator mandibulae anterior; *map.*, maxillopalatine; *max.*, r. maxillaris V; *mco.*, M. constrictor orbitalis; *ob.*, os Basale; *oc.*, orbital cartilage; *op.*, r. ophthalmicus profundus V; *par.*, parietal; *pls.*, pleurosphenoid portion of os Basale; *sq.*, squamosal; *tc.*, trabecular cartilage.

The choanal glands (*Choanendruse*, Sarasins 1890) in *U. narayani* (Pl. VI. fig. 6. *chg.*) open into the choana as in *I. glutinosus* and *I. monochrous*. Again no reference is made to this in *U. menoni* (Fahrenholz 1934). The presence of this gland is recorded by de Jager in *D. mexicanus* and not in *D gregorii*. In *Herpele*, opening into the choana there are a few choanal glands; in *Scolecomorphus* the choanal glands are similar to the intermaxillary glands of Fahrenholz and open into the posterior portion of the choana and *Boulengerula* also possesses a set of choanal glands.

The dental and sublingual glands (*dentaldruse*, *sublingualdruse* Mang 1935) are disposed in *U. narayani* (Pl. VI, fig. 1, *slg.*) as in *Hypogeophis*.



TEXT-FIG. 15.—*Herpele ochrocephala* (Cope)

Transverse section showing oral mucous glands: ×55.

aci., arteria carotis interna; *am.*, angle of mouth; *br*, brain; *cp*, "caput preorbitale" of M. l. m. internus; *f.*, frontal; *lma*, M levator mandibulae anterior; *lmi.*, M. levator mandibulae internus; *map.*, maxillopalatine; *max*, r. maxillaris V, *ob*, os Basale; *oc.*, orbital cartilage; *op.*, r. ophthalmicus profundus V, *org.*, oral gland; *par*, parietal; *pf.*, r. palatinus facialis; *q.*, quadrate; *sq.*, squamosal; *vcl.*, vena capitis lateralis:

The bursa angularis oris (Fuchs 1931).—The occurrence of a bursa angularis oris has already been noted among Anura and in some am-

niote examples (Fuchs 1931). I have already noted (1934) that this structure is absent in *Ichthyophis* and *Uraeotyphlus*. In *Scolecomorphus* (text-fig. 14, *bao*), however, it appears as a lymphocytic accumulation between the anterior end of the squamosal (*sq.*) and the compressor muscle of the orbital gland (*mco.*) and soon a cavity is noticed in it when the M. levator mandibulae anterior (*lma.*) is situated dorsally to it. The cavity of the gland (?) does not communicate with the buccal cavity as in anuran examples. Posteriorly, this structure disappears at the angle of the mouth.

In *Herpele*, a set of mucous glands appears in between the M. levator mandibulae internus (text-fig. 15, *lmi.*) and the "Caput preorbitale" (*cp.*) of the same and the M. levator mandibular anterior (*lma.*) just above the maxillopalatine bone (*map.*). Posteriorly they open into the buccal cavity. These are different histologically from the bursa angularis oris, but their anterior position and their opening into the buccal cavity are rather significant. These are obviously mucous glands of the skin which have migrated far internally.

THE TONGUE.

The apodan tongue is a padlike ∩-shaped structure in the anterior portion of the floor of the mouth and is incapable of eversion as in Anura. The earliest reference made to the apodan lingual organ is by J. Müller (1831) where he referred to the bilobed papillae in *Ichthyophis*. Sentzen[1] described the tongue of *Caecilia tentaculata*, while Widersheim (1879) referred briefly to the elevated lateral portions of the tongue of *C. lumbricoides* (*C. gracilis*).

Teipel (1932) gave a complete account of the development of the tongue of *Hypogeophis* and also its adult structure. Both Marcus (1932) and Teipel remark that in a transverse sectional view the tongue of *Hypogeophis* is roughly divisible into lateral and median parts. The median part is highly vascular and glandular while the raised lateral parts are free from glands but the genioglossus muscle is inserted into them aiding the animal in respiratory activities.[2] This exclusive differentiation of the tongue into a median glandular and a lateral muscular part is disproved by Mang (1935) for he says (p. 304):

> Vier Querschnitte dieser Serie sind in der Zungenarbeit von Teipel in der Abb. 3 veroffentlicht. Auch in seiner Abb. 2 ist eine a graphische Horizontalrekonstruktion der Zunge von dieser Serie gemacht, um zu ziegen, dass die mittlere Zunge nur vorn von Drüsen erfullt ist. und wie sich die Drüsen erst weiter hinten und beim erwachsenen Tier auch auf die seitlichen Zungenteile erstrecken. Dabei muss diese Zeichnung fur die Drüsen als unvollstandig bezeichnet werden, da seitlich die Drüsen sich uber die Zunge hinaus erstrecken.

However, it must be pointed out that the few scattered glands to which Mang refers appear only posteriorly to the insertion of the muscle in the lateral part.

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[1] Quoted by Teipel (1932).

[2] Marcus has informed me (in. litt.) that he does not agree with the views of Kallius (1901) and Gegenbaur (1894) that the glandular activity was the primary cause of the muscularisation of the tongue.

In the case of *I. glutinosus*, *I. monochrous* (Mahadevan 1936), *U. menoni* (Chatterjee 1936) and *U. narayani*, the pad-like tongue observes the shape of an inverted U. Further, the tongue in *Ichthyophis* (Pl. V. fig. 3) and *Uraeotyphlus* (Pl. VI, fig. 2) is not divisible into median glandular and lateral muscular parts, but the two lateral limbs of the ∩-shaped tongue project posteriorly. The tongue proper is covered over by stratified epithelium (*se.*) on the surface of which open a large number of glands (Pl. V, figs. 2, 3, *lg.*) and the latter are not supplied with sphincter muscles as in *Hypogeophis* (Teipel 1932). The glands are larger and are more vertically elongated in *I. monochrous* (Pl. V. fig. 3, *lg.*) than in *I. glutinosus* and *U. narayani*. These tongue glands show quantities of mucus which can be stained by mucicarmine and obviously this secretion keeps the surface of the tongue moist, probably aiding the animal in deglutition. In *U. narayani*, the anterior tip reveals in sectional views (Pl. VI, fig. 1) a large number of blood vessels in the ventral aspect and a set of glands (*lg.*) dorsally; in the prechoanal portion, the lateral parts (Pl. VI. fig. 2, *lt.*) of the tongue are separated by the mesial ciliated pharyngeal portion. Buccal glands (*pg.*) occur in this middle portion (the postlingual glands of Mang) and thus a transverse section gives the spurious appearance of the tongue being divided into lateral muscular and mesial glandular parts. I do not consider this mesial section as a part of the tongue for, it correctly belongs to the pharyngeal region. Further, I am inclined to believe that the central glandular part described by Teipel (1932) in *Hypogeophis* tongue is really the pharyngeal part with its glands. Where the lingual muscle,—M. genioglossus appears (M. hyoglossus being absent from the tongue of Apoda so far examined), the major portion of this enters the lateral part as in *Hypogeophis* while a few fibres proceed to the median part also.

The mucous glands referred to above in the tongue make their appearance only in late larval life of *I. glutinosus*. Mang (1935) points out that in his preparations of stages 48 and 49 of *Hypogeophis* the tongue is lined by simple epithelium (single layered; he does not mention if it is ciliated as in *Ichthyophis*), but the epithelial cells are loaded with vitreous mucus. At any rate the glands seem to make their appearance in the next stage, 50 (7 cm. long larva),—a stage where the external gills are still persisting. According to him an invagination appears in the determined area and the cells commence to secrete mucus. In *I. glutinosus* on the other hand, it is the embryonic stage which is branchiate as already remarked, measures 6-7 cm. in length and obviously the time of development of the glands does not follow that in *Hypogeophis*. I have examined in this connection a young stage of *U. narayani* that I have with me (9 cm.), in this all the adult features have already made their appearance but only they have not grown to their maximum size. The tongue and the associated glands and the glands of the buccal cavity including the intermaxillary (though feebly) have made their appearance. *Uraeotyphlus* as compared to *Ichthyophis*, has a greatly abbreviated larval life, for the appearance of most of the characters like the tentacle, nasolacrimal ducts and the complete development of the eye muscles which only develop in late

larval life of *Ichthyophis*, are compressed into the very early larval life or they may even appear in the embryonic condition. I am inclined to believe that the embryonic life of *U. narayani* is very short and most of the characters enumerated above are heralded in this stage and when the larva is hatched, it is supplied with the full complements of an adult individual, only not so completely. This point can be confirmed only after examining embryos and as more material becomes available. I hope to study the early development of this interesting apodan type.

In *D. gregorii*, the lingual organ is well developed and in the choanal region (Pl. VI, fig. 3) the entrance of a few fibres of the genioglossus muscle into the central pharyngeal region can be made out. The glands are uniformly distributed in the tongue.

In *H. ochrocephala*, anterior sectional views reveal the presence of large sublingual glands and the tip of the tongue appears as a projection. Photomicrograph (Pl. VI, fig. 4) shows the lateral muscular portion (*lt.*) free from glands and the central cilited pharyngeal region full of glands (*pg.*). It can also be seen that a few fibres of the genioglossus muscle enter the middle portion. Posteriorly, in the middle of the pharyngeal region, a groove appears into which the glands open.

In *Scolecomorphus*, since the second row of teeth is absent in the lower jaw, the anterior sections reveal a large number of sublingual glands extending between the jaws. The tongue no doubt observes the shape of an inverted U, but is not raised above the level of the jaw. The muscles (Pl. V, fig. 4) are inserted into the lateral aspect while the glands occupy the central ciliated area. In *Boulengerula* also (Pl. VI, fig. 7) the same features are noticed.

The study of the tongue in the Apoda reveals that the distribution of the lingual glands is rather interesting. In the tip (*i.e.*, at the anterior end of the ∩-shaped tongue) a set of glands is always present. In the lateral portions of the tongue, the genioglossus muscle is predominantly noticed; the absence of glands from this part is noticed in *Uraeotyphlus*, *Herpele*, *Scolecomorphus*, *Boulengerula* and *Ichthyophis*, while in *Dermophis* glands are also seen in the lateral parts.

According to Teipel (1932), three nerves enter into the tongue. The hypoglossal (XII) innervates the genioglossus muscle and the glossopharyngeal (IX) enters the median portion of the tongue. A ramulus from the united mandibular nerve (chorda tympani VII *plus* ramus mandibulari internus V) passes into the tongue as ramus lingualis. The lingual innervation by a branch of the chorda tympani is an important feature, for in this feature the Apoda simulate the higher tetrapodous forms (*see* Cranial nerves).

THE OLFACTORY ORGAN AND ASSOCIATED GLANDS.

The first cavity that we meet with in the anterior region of the olfactory organ is what Wiedersheim (1879) described as the cavum nasale principale. In the case of *I. glutinosus* (Wiedersheim 1879, Waldschmidt 1887, Sarasins 1890), *Geotrypetes* (Norris and Hughes 1918), *Dermophis* (Norris and Hughes 1918, de Jager 1939), *I. monochrous*

and *Scolecomorphus uluguruensis*, owing to the development of an eminentia olfactoria (processus conchoides, composed of projections from prevomer and sphenethmoid bones), the cavum nasale principale is incompletely divided into a median and a lateral chamber. According to Sarasins (1890), the lateral part is composed not only of a sensory part in which glands of Bowman are present, but also a ciliated respiratory part. Thus it is incorrect to say that the lateral part is purely respiratory, as de Jager (1939) has described. She noted that (p. 194) "The median olfactory part consists of olfactory cells which are absent from the lateral respiratory part with its cubical epithelium and mucous cells (Fig. 1). This typical division of the cavum nasale principale into two parts has been universally stressed". It should be noted here that the typical division of the cavum nasale principale is seen only in cases where an eminentia olfactoria is developed (*see* text-fig. 4, *mcp., lcp.*) and in these the lateral portion is composed of not only respiratory but also olfactory epithelium. However, in an account of the olfactory organ of *H. rostratus*, Laubmann (1927) has not referred to a sensory or respiratory part but simply describes the cavum nasale principale (Hauptnase or chief nose) as formed of a lateral nose and a median one with a sulcus differentiating them. Marcus (1930) has also referred to the "Hauptnase" but does not allude to the physiological separation. This condition has also been noticed in *C. gracilis*, *U. oxyurus*, *Chthonerpeton indistinctum*, *S. annulatus* (Wiedersheim 1879) *Herpele* and *Caecilia* (Norris and Hughes 1918) and *U. narayani* (text-figs. 1, 3, 8, 9, *mcp., lcp.*) and *B. boulengeri*.

A second cavity which we meet with in the sectional views of the apodan head in the narial region is the "Nebennase" of Wiedersheim (1879) or the organ of Jacobson (Sarasins 1890). Laubmann (1927) described this cavity as "Tastnase" or the organ of touch in the nose of *H. rostratus*. Marcus (1930) doubted the validity of this interpretation and therefore called this cavity as "Nebennase" (secondary nose), and I have followed the nomenclature employed by Wiedersheim and Marcus. The "Nebennase" opens into the tentacular sac by two ducts (text-figs. 1, 2, 8, 16, *nld.*) and internally, it (text-fig. 9, *nn.*) opens into the mesial or into the lateral part of the cavum nasale principale. As regards the internal opening, it is significantly pointed out by Norris and Hughes (1918) that "The development of a processus conchoides produces other modifications of the nasal topography. Jacobson's organ ["Nebennase"], which in *Herpele* and *Caecilia* (figs. 8, 9, 10) connects with the mesial portion of the nasal chamber, in the other type communicates with the lateral portion (figs. 6, 7, 10)".

The two ducts opening into the tentacular sac, called "Tranenröhrchenen" (lacrymal ducts) by Sarasins, were first discovered by Leydig (1868) in *S. annulatus* and *C. gracilis* and were called by him "falschen Nasenöffnung" (pseudonasal opening). Wiedersheim (1879) described the two ducts of the "Nebennase" opening into the tentacular sac as tentacle canals for he thought that these emptied the secretion of the glands surrounding the "Nebennase" (which he therefore erroneously called the "tentakeldrüse") into the tentacle sac and Greeff (1884) working on *D. thomensis* confirmed the observations of Wieder-

sheim. Laubmann (1927) differed from these two authors and called these two ducts as "Tastnasenröhrchen" and ascribed a different function to the "Nebennase". On account of the constant exsertion and withdrawal of the tentacle, a certain amount of air gets into the "Nebennase" through the "Tastnasenröhrchen" and the former is thus enabled to function as an "Organ of touch" and he therefore, called the "Nebennase" as "Tastnase" (the nose where the seat of touch is located). According to this author, then. the air that is taken in through the anterior nares and also through the tentacular nasolacrimal ducts helps the animal in olfaction, in feeling and also in respiration.[1] Marcus cautiously remarks (1930, p. 662):

> Ob der Tentakel ein echter 'Tastfühler' sei, also erhebliche Tacktile Reize vermittelt. lasse ich dahin gestellt.

and further notes that during borrowing, the anterior nares close up and air is led into the nose by the tentacular ducts ("Nebennasenröhrchen") for respiration and olfaction and when the latter close up, air enters through the anterior nares. This ingenious explanation will hold good in a form like *Hypogeophis* where the tentacle is far behind the anterior nares; but in those cases where the tentacle and, therefore, the openings of the nasolacrimal ducts are below the anterior nares as in *Uraeotyphlus*, air cannot be led in during borrowing (provided these animals lead a subterranean life) for both inlets will be closed. In fact, *Ichthyophis* is not a borrower at all. for all the specimens collected so far are from under decaying vegetation or wood in moist surroundings. Therefore, these Apoda may be described as "surface cryptic" forms.

In *U. narayani*, the "Nebennase" (text-fig. 16, *nn.*) is elongated longitudinally and its two ducts (nasolacrimal ducts, *see* text-figs. 1, 8, *nld.*) open into the tentacular sac as in other forms. The internal opening into the median part of the cavum nasale principale is situated by the side of the sphenethmoid.

The organ of Jacobson is also described by Laubmann (1927) and Marcus (1930. Fig. 5) in *Hypogeophis*. This is a diverticulum (Laubmann. Figs. 9*a*, 9*b* and 9*c*) of the cavum nasale principale opening into the latter and in the same region the opening of the "Nebennase" can also be seen. According to this author. the Jacobson's organ is developed as a result of the mechanical rotation of the nasal organ. Such a structure is not noticed by me in *U. narayani* and also by other workers in the genera examined by them.

Sarasins' (1890) described a third cavity which they called "Choanenschleimbeutel" and Wiedersheim (1879) also described this third cavity in association with "Nebennase". De Jager (1939) mentions that Laubmann (1927) does not refer to a "Choanenshleimbeutel"; however, we read in Laubmann that in the choanal region there is a cavity with a valve opening towards the choana. Marcus (1930) describing the same animal as Laubmann, noted that a posterior portion

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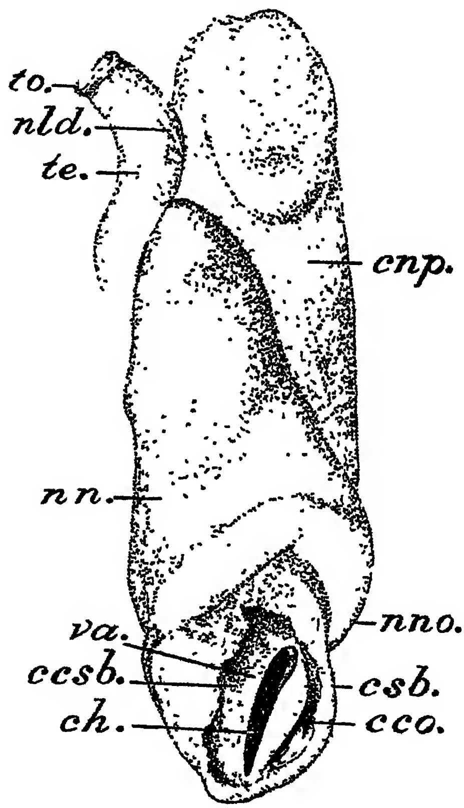
[1] Sarasins (1890, p. 199) had already noted that the nasolacrimal ducts led air into the nose, but could not ascribe any function to it.

of the olfactory sac could be homologised with Sarasins' "Choanenshleimbeutel". He says (p. 679).

> Durch die eben beschruebene Falte im hinteren Nasengang (Choanenschleimbeutel der Vettei Sarasin) ist ein Mechanismusgegeben, der wie eine Ventilklappe die hauft bei der Ausatmung in jede der beiden Nasenteile dirigieren kann.



TEXT-FIG. 16.—*Uraeotyphlus narayani* Seshachar.

The olfactory organ from ventral aspect: the wall of the "Choanenschleimbeutel" is cut to show the cavities inside. Only one nasolacrimal duct is visible: ×24.

cco., cavity of the "Choanenschleimbeutel" into which choanal glands open: *ccsb.*, cavity of the "Choanenschleimbeutel"; *ch.*, choana; *cnp.*, cavum nasale principale; *csb.*, "Choanenschleimbeutel": *nld.*, nasolacrimal duct; *nn.*, "Nebennase"; *nno.*, the bend of "Nebennase" before it opens into "Choanenschleimbeutel"; *te.*, tentacle; *to.*, tentacular orifice; *va.*, valve.

The occurrence of this choanal chamber (text-figs. 3, 4, 16. *csb.*) with a valvular flap (*va.*) is a common feature among the apodan genera studied by me.

The nasal glands.—In addition to the glands of Bowman in the olfactory epithelium, two more sets of glands can be identified in the nasal region of Apoda generally. These are, (1) Nasal glands (Nasendrüse) situated dorsally or dorsolaterally (Pl. V. fig. 4 and text-figs. 3, 4, 9, *ng.*) in posterior sectional views to the cavum nasale principale

opening into the latter by ducts. These were first described by Wiedersheim (1879) in *S. annulatus*, *C. gracilis* and *H. rostratus*, *U. oxyurus* and *Chthonerpeton indistinctum*. The presence of the same was noticed by Sarasins (1890) in *I. glutinosus* and they are have been designated as "dorsale Drüse" in *H. rostratus* by Laubmann (1927). In *Herpele*, Norris and Hughes (1918) delineate these glands in their fig. 8 and I have also observed them in my preparations. In *D. mexicanus*, Norris and Hughes represent them in their figs. 5, 6 and 7 and de Jager (1939) also confirms this both in *D. mexicanus* and *D. gregorii*; I have observed their presence in the latter species also. In *Boulengerula* and *Scolecomorphus*, my sectional views show well developed glands as also in *I. monochrous*. Obviously, the glands occur uniformly in the Apoda. (2) The glands of the "Nebennase" (Nebennasendrüse). Wiedersheim (1879) described the glands opening into the "Nebennase" as the "tentakeldrüse" for, the two ducts of the "Nebennase" were thought to arise from these glands and open into the tentacle sac. Sarasins (1890) described the glands opening into the "Nebennase" as the "Drüse der Jacobson'sche Organ". Norris and Hughes (1918) followed Sarasins's nomenclature. Laubmann (1927) described in *H. rostratus* "Tastnasendrüse" associated with the "Tastnase". De Jager (1939) noted that these glands open into the choanal chamber in *D. mexicanus* while in *D. gregorii*, few glands are embedded in the "ventrolateral wall of the choanenshleimbeutel into which they open", unlike what has been described by Wiedersheim, Sarasins and Laubmann, where the glands open into the secondary nose. In *U. narayani*, a large number of glands (text-figs. 3, 9, *nng.*) surround the lateral part of the "Nebennase" and open into it.

THE TENTACLE.

Englehardt (1924) and Laubmann (1927) put forward the view that the tentacle in the Apoda is an organ of touch ("Tast-organ"). But Marcus (1930) pertinently points out that it is a "Klopf-fühler" helping the cryptic animal in respiration and smelling. He says (p. 659).

> Dagegen ist es sehr wahrscheinlich, das die Klopf-fühler der unter der Erde bohrenden Blindwühle des Atmen und Reichen durch die Nebennase erlauben, wenn die vorderen Narinen fest verschlossen sind, indem sie freien Atemraum schäffen.

Wiedersheim (1879) gives a dissected horizontal view of the M. retractor tentaculi in *C.* (*Uraeotyphlus*) *oxyurus*, where the tentacle enclosed in the tentacular canal into the tip of which the opening of nasolacrimal ducts, orbital glands and glands of the nasal region are shown. In the case of *Ichthyophis* (Sarasins 1890, Englehardt 1924), it has been noticed that the tentacular part (stopsel) which projects beyond the skin is covered partially at its base by a fold of the same (tentakelfalte) which extends internally also; this tentacular fold to which the retractor muscle is attached moves up and down in the tentacular sac (tentakelsack). The tentacle is retracted by the M. retractor tentaculi. Sarasins (1890) ascribed the exsertion of this to erection, but Marcus

(1930) in this connexion noted that the M. compressor glandulae oculi functioned not only as a compressor of the gland but also as a protractor of the tentacle.

In *Uraeotyphlus*, the external tentacular fold referred to above is absent and the tentacle itself is short and blunt, and I have not been able to detect any sensory innervation.[1]

The homology of the retractor muscle which controls the activity of the tentacle has not been definitely settled. Sarasins (1890) was doubtful whether it was a part of the rectus internus or a modification of retractor bulbi. Marcus (1910) also believed in the retractor bulbi modification. Norris and Hughes (1918) described in the case of *Herpele* and *Caecilia* that the retractor muscle was a modified rectus externus muscle. Edgeworth (1935) considered it to be a modified retractor oculi. De Jager (1939) referred to the retractor muscle as a modified rectus externus. It is known in all these cases. that the abducens nerve innervates the rectus externus and also the retractor bulbi; it is natural therefore, to expect one of these muscles to be modified into a retractor tentaculi. In all the cases so far examined in *Ichthyophis* (Sarasins 1890, Norris and Hughes 1918, Englehardt 1924), *Dermophis* and *Geotrypetes* the M. rectus externus is present and the retractor bulbi is absent (*vide* Eye muscles, where I have shown that the retractor bulbi of Norris and Hughes, is a rectus medialis), and it can be surmised that the latter muscle is converted into the retractor tentaculi. But in those forms where the eye muscles are completely degenerate (*Herpele, Caecilia, Scolecomorphus, Boulengerula*) one of the two muscles innervated by the abducens may have been transformed. But in *Ichthyophis*, it has been shown by Englehardt (1924) that the retractor muscle is double, and is separated by a connective tissue layer (*see* also Norris and Hughes 1918, fig. 19) and therefore, finds comparision with the double retractor bulbi of *Triturus*. Such a double condition, I have also noticed in *Uraeotyphlus*, *I. monochrous*, *Scolecomorphus*, *Dermophis* and *Boulengerula*, suggesting thereby that in forms where the eye muscles are degenerate, the M. retractor tentaculi may be a modified retractor bulbi. As in *I. glutinosus*, the double nature of the retractor muscle becomes obvious when the rectus internus passes through the former in *I. monochrous*, *Dermophis* and *Uraeotyphlus*. In the latter the muscle ends in the region of the optic foramen as in *Dermophis*. In *Scolecomorphus*, a large M. retractor tentaculi (*see* text-fig. 4, mrt_1) is noticed and in addition to this, there arises one (mrt_2) from the tentacular fold which is separated from the retractor by orbital glands (*og.*). Postchoanally these two merge into each other and are surrounded by the compressor muscle. The retractor muscle is inserted on the os Basale ventrally to the trigeminal foramen. In *Boulengerula*, the retractor insertion into the tentacle is far anterior and in the choanal and postchoanal regions the muscle is noticed in two parts being separated by orbital glands. Posteriorly the double nature is retained and the muscles postoptically are inserted into the os Basale.

[1] I have not used any special stains for detecting sensory innervation.

THE EYE AND ITS MUSCLES.

It is well known that in the Apoda, the eye may be covered over completely or it may be visible externally. Structural degeneration naturally accompanies the condition where the eye is hidden as in *Herpele. Caecilia. Scolecomorphus*, etc.

Wiedersheim (1879) briefly referred to the eye of *Siphonops*.

While de Jager (1939) remarked that the eye was degenerate in *Dermophis*, I find that the eye is well developed with all its six muscles. Norris and Hughes (1918) clearly demonstrated this and I reproduce a photomicrograph (Pl. VI, fig. 5) to show a well developed eye and the associated structures like eye muscles (*em.*), orbital glands (*og.*), M. retractor tentaculi (*mrt.*) and optic nerve.

In *Boulengerula*, Nieden (1913) noted that the "Augen unter den Schädelknochen verborgen" and de Villiers (1938) also remarked that in *Boulengerula*, "The eye is totally degenerate and hidden beneath the paraquadrate as in *Scolecomorphus*" confirming the observations of Peter (1908, Fig. 8). Nieden made the same remark about *Scolecomorphus*, and obviously de Villiers follows that author in saying that the 'totally degenerate' eye is hidden below the paraquadrate (squamosal), which however, appears only posteriorly, nor is it hidden for that matter under any bone. The photomicrograph reproduced (Pl. V, fig. 1) shows that it (*e.*) is directed towards the lower jaw and is devoid of a lens, of eye muscles and nerves including the optic. Towards the maxillopalatine bone, the eye is partially surrounded by the tentacular sac into which the orbital glands (*og.*) open. After the eye disappears from sections, the M. retractor tentaculi appears attached to the wall of the tentacular sac.

In the case of *Herpele* examined by me, the eye is not only degenerate but is also hidden under the maxillopalatine bone.

In *U. narayani*, the eye is well developed both in the young and the adults examined as in *I. glutinosus* and *I. monochrous*. The photomicrograph (Pl. VI, fig. 6) passes through the optic nerve (*on.*) region and in the eye, a sclerotic, choroidea (pigment), iris, retina, cornea and lens (not seen in figure) can be clearly made out besides some of the eye muscles.

As early as 1868, Leydig described four eye muscles in *Siphonops*, but Wiedersheim (1879) does not refer to them. Sarasins (1890) described in *I. glutinosus* six eye muscles; four rectus and two oblique in association with a retractor tentaculi which probably is a modified M. retractor bulbi. Marcus (1910) found all the eye muscles in *Hypogeaphis* larva including a levator bulbi muscle (compressor muscle of the orbital gland). He also described a M. retractor tentaculi which he derived from the retractor bulbi (*c.f.* the tentacle). Norris and Hughes (1918) described in *Dermophis* six muscles: superior and inferior oblique (dorsal and ventral oblique), superior and inferior rectus (dorsal and ventral rectus), a rectus externus (r. lateralis) and a rudimentary retractor bulbi. A rectus internus (r. medialis) is absent, while a retractor tentaculi is present. According to the same authors in *Geotrypetes*, all the rectus and oblique muscles except r. internus, and a retractor bulbi and two retractor tentaculi muscles (a M. retractor

tentaculi and a M. retractor of the tentacular sheath,—the latter considered by them to be a modified r. internus) are present. In *Herpele* and *Caecilia* the eye muscles are absent; however, the tentacular muscle is described as a modified M. rectus externus.

Englehardt (1924) in his account of the tentacle and eye of *I. glutinosus*, records six eye muscles. While the obliquus superior is lost between the ethmoid cartilage and orbital gland, the inferior oblique is lost between the retractor (R2) and orbital gland ventrally. Of the rectus muscles, the medialis ends in the connective tissue between the retractor and orbital gland; the lateralis in between the orbital gland ducts an retractor; the superior and inferior end between the compressor and orbital gland ducts. According to the same author the oculomotor innervates the rectus and obliquus inferior muscles.

Edgeworth (1935) followed the works of Norris and Hughes (1918) and Englehardt (1924) and recorded that the ocular muscles and nerves were present in *Ichthyophis*, *Dermophis* and *Geotrypetes*. while "in *Caecilia* and *Herpele* the eye is partly or fully covered by maxilla and is rudimentary". A retractor tentaculi innervated by abducens nerve and homologised with the retractor bulbi (retractor oculi) of Urodela and Anura is also recorded.

de Jager (1939) reported (erroneously) that all the eye muscles have degenerated in *D. mexicanus* and *D. gregorii* except the r. externus which has become the M. retractor tentaculi.

Both in *I. monochrous* and *U. narayani*, all the eye muscles are present,—two oblique and four rectus muscles. Tracing the sections rostrocaudally, in *U. narayani*, it is noticed that the oblique muscles appear arising from the connective tissue covering the maxillopalatine towards the eye. While the insertion of the obliquus superior is noticed on the eye-ball in the anterior sections, that of the inferior appears more posteriorly. Between the o. superior and inferior and enclosed within the orbital glands, the rectus internus is seen. In a region where the rectus internus enters the m. retractor tentaculi, the insertion of the o. superior and inferior and the rectus inferior can be seen. Posteriorly, the r. superior and inferior enclosed within the orbital glands and the rectus externus inserted on the eye-ball can be made out. The rectus internus passes through the M. retractor tentaculi as in *I. glutinosus* (Englehardt 1924) and along with the rectus superior is lost between the orbital gland, M. retractor tentaculi and the compressor muscle. The rectus externus and inferior become so thinned out in the region between the connective tissue spanning the orbital and trabecular cartilages and the compressor muscle that it is difficult to trace them further. In both *Ichthyophis* and *Uraeotyphlus*, a retractor bulbi is absent as such and is modified into the tentacular muscle. However, according to Norris and Hughes (1918) in *Geotrypetes* and *Dermophis*, a rectus internus is absent and they note that in these two (p. 507) "a delicate muscle slip follows the optic nerve from the retractor tentaculi to the eye-ball, probably a retractor bulbi". Moreover, in the case of *Geotrypetes*, the retractor of the tentacular sheath is homologised with the rectus internus because of position and innervation. In *Ichthyophis*, the same authors state that the eye

muscles are as described by Sarasins (1890, Fig. 72, four rectus and 2 oblique). It is clear therefore, that Norris and Hughes have accepted the muscle passing through the retractor tentaculi to the eye-ball as rectus internus in *Ichthyophis* (*see* their Fig. 19) to which, however, they assign the name of a retractor bulbi in *Dermophis* and *Geotrypetes* and thus deny the presence of a rectus internus. Having examined *Dermophis*. *Ichthyophis* and *Uraeotyphlus*, I am convinced that the muscle designated as retractor bulbi by Norris and Hughes is actually the rectus internus which, as described by Englehardt passes through the retractor muscle and therefore, contrary to the observations of Norris and Hughes and de Jager, all the eye muscles are well developed in *Dermophis*.

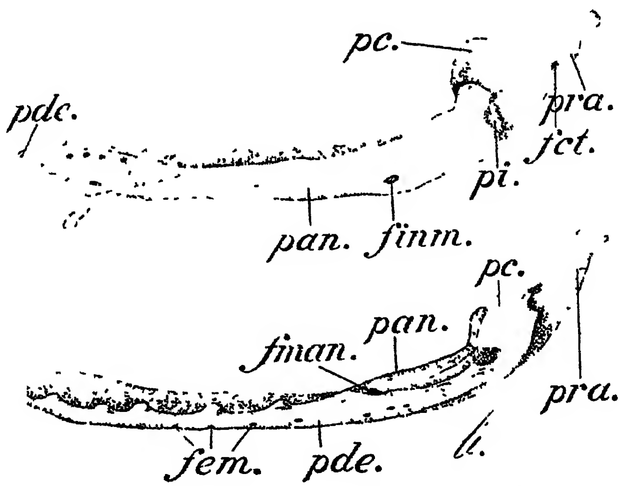
THE LOWER JAW.

Sarasins (1890) did not describe the lower jaw bones in detail but noted that it is composed of a dentary and an articular and that the inner tooth row belongs to the opercular (spleniale). Marcus, Winsauer and Hueber (1933) described in the case of *Hypogeophis*, a posterior gonial and an anterior dentary. The dentary carries the two rows of teeth. The gonial with which the articular fuses to form a gonioarticular, in the region of the suspension gives internally to a process,—the processus internus and laterovertically to a process—the processus condyloides (processus articularis mandibularis, Luther 1914), which articulates with the external aspect of the processus articularis of the quadrate and the jaw proceeds posteriorly as the processus retroarticularis mandibulae (Luther).

According to Eifertinger (1933) each ramus of the jaw consists of two composite bones, formed by the fusion of a number of elements during development. The posterior pseudoangular (gonioarticular) is composed of angular, gonial (prearticular, de Beer 1937), complimentary, and articular while the pseudodentary is formed by mentomandibular (mentomeckelian, de Beer 1937), dentary, splenial, coronoid and supraangular. The anterior portion of the dentary, the articular and the mentomeckelian are cartilage bones and the rest are membrane bones. This nomenclature of the fused bones in the lower jaw was accepted by Marcus (1933), but he pointed out that the pseudodentary is composed of dentary, mentomandibular, splenial and coronoid (no mention is made of supraangular) while the pseudoangular is formed by angular, gonial (complimentary ?) and the articular. In his fig. 6c Eifertinger (1933) describes in the posterior part a gonial and angular while in fig. 7*a* (44 mm. *Hypogeophis* larva) a gonioangular and extra element 'complimentare' are noted. Marcus (1933) however, while labelling a separate gonial and angular in his fig. 2*b* described (as gonial in fig. 2*c*), the region called by Eifertinger as 'complimentare'. He significantly mentions in this connexion that (pp. 181, 182)

> In der Abb. 2c ist durch 4 Punkte, welche die Naht zwischen Dentale und Coronoid caudal fortsetzen angedeutet, dass im Goniale G oft die Spitze des Knochens selbständing verknöchert, und so vielleicht einem Complementare entspricht.

In *U. narayani*, as in *Hypogeophis*, two segments in each ramus of the lower jaw can be made out; a pseudodentary (text-fig. 17*a*, *b*. *pde.*) and pseudoangular (*pan.*). No exact differentiation into regions



TEXT-FIG. 17.—*Uraeotyphlus narayani* Seshachar.

a. the lower jaw from within: ×9.

b. outer view, slightly inclined: ×9.

fct., foramen for chorda tympani; *fem.*, foramina for the twigs of ramulus mandibularis externus V; *finm.*, foramen for ramulus intermandibularis; *fman.*, foramen for ramulus mandibularis V; *pan.*, pseudoangular; *pc.*, processus condyloides; *pdc.*, pseudodentary; *pi*, processus internus; *pra.*, processus retroarticularis.

where the original independent bones were present could be made out. A processus condyloides (*pc.*), a processus internus (*pi.*) and a posterior processus retroarticularis (*pra.*) are present. The orifices for the entry of ramus alveolaris VII (chorda tympani) (*fct.*) and the ramus mandibularis V (*fman.*) in the pseudoangular can also be seen. Anteriorly the pseudodentary of either side is united at the apex of the jaw into a symphysis by a reminiscent piece of cartilage. Two rows of teeth are borne upon this bone.

While the processus condyloides (*see* text-fig. 7*a*, *pc.*) is prominently developed in *Uraeotyphlus* [compared by Hueber (1933), with the 'Hammer, Haupteil' of the mammalian ear] it is feebly developed in *Herpele* and *Dermophis* and *Scolecomorphus*, and is absent in *Boulengerula*.

THE JAW MUSCLES.

The latest account dealing with the development and disposition of adult arrangement of masticatory muscles is by Edgeworth (1925, 1935) who distinguishes four of them. I have employed the same nomenclature in describing the jaw muscles of adult *Uraeotyphlus* as Edgeworth.

Edgeworth (1925, 1935) considers the two muscles adductor mandibulae externus and adductor mandibulae internus (M. pseudotem-

poralis) of Hueber[1] as a single one since they arise singly in the early stages. He however, adds (Edgeworth 1935. p. 42) that "it separates into medial and lateral parts", and nerves pass through these two. But in [adult] *Ichthyophis* and *Siphonops*, according to the same author the muscle "persists as a whole". I have examined adult *Ichthyophis*. and it shows the separation of the muscle into two, as described by Luther (1914, p. 9, fig. 3) with its origin and insertions as in *Uraeotyphlus* (*see* below). Whatever the origin of these two parts of the muscle may be, it will facilitate description if we could give them distinct names and, therefore, I have called the M. pseudotemporalis as M. levator mandibulae internus and the M. adductor mandibulae externus (Hueber) as M. levator mandibulae anterior.

The four masticatory muscles are :—

(1) M. levator mandibulae anterior (Edgeworth 1925, 1935) (Synonyms : M. Adductor mandibulae externus major *plus* M. pseudotemporalis. Luther 1914, Hueber 1933.
M. temporalis. Norris and Hughes 1918.
M. Masseter 1.
M. temporalis 1. Englehardt 1924.)
M. temporalis 2.

(2) M. levator mandibulae externus (Edgeworth 1925, 1935) (Synonyms : M. Adductor mandibulae externus minor. Luther 1914.
M. masseter 2. Norris and Hughes 1918.
M. masseter. Englehardt 1924.
M. Adductor mandibulae posterior. Hueber 1933.)

Luther (1914) described no M. adductor mandibulae posterior in Apoda, but Hueber (1933) has since described the same in *Hypogeophis*.

(3) M. levator mandibulae posterior (Edgeworth 1925, 1935) (Synonyms : M. pterygoideus *sic.* Luther 1914, Norris and Hughes 1918, Hueber 1933.)

According to Edgeworth (1925) this muscle is homologous with the same muscle in Anura and Urodela.

(4) M. levator quadrati (Synonyms : *sic* Luther 1914, Norris and Hughes 1918, and Hueber 1933. M. pterygoideus Englehardt 1924.)

According to Edgeworth (1925, 1935) the opinion of Hueber that the M. levator quadrati is homologous with the M. constrictor dorsalis of fishes, is incorrect for, the latter did not adduce any embryological evidence in favour of his opinion.

In *Uraeotyphlus* (text-fig. 10, *lma.*), the M. levator mandibulae anterior arises from the frontal bone and is inserted on the pseudoangular of the lower jaw. Internally to this muscle, the M. levator mandibulae internus (*lmi.*) is noticed along with the "Caput preorbitale" (*cp.*) (*see* Luther 1914, p. 69) and the origin of the latter is described below. Both these muscles (l. m. internus and the "Caput

[1] *See* Marcus, Winsauer and Hueber, p. 171, 1933.

preorbitale" portion) are inserted on the pseudoangular by a common tendon while the M. levator mandibulae internus arises from the dorso-lateral aspect of the pleurosphenoid.

The M. levator mandibulae externus (text-figs. 10, 11, *lme.*) arises principally from the processus ascendens of the quadrate bone and is also inserted into the pseudoangular of the lower jaw.

The M. levator mandibulae posterior (text-figs. 11, 12, *lmp.*) arises from the ventral aspect of the processus pterygoideus of the quadrate and the insertion is on the retroarticular process of the pseudoangular. In *Scolecomorphus* (text-figs. 13*a*, *b*), it is noticed that the M. levator mandibulae posterior has a separate origin instead of from the ventral aspect of the processus pterygoideus as in other Apoda. This process is very small and the M. l. m. posterior arises from the anterior face of the basipterygoid process where the connective issue strand (*cs.*) from the processus ascendens (*pa.*) comes and meets it.

The M. levator quadrati (text-fig. 10, *lq.*) arises from the lower aspect of the pleurosphenoid bone and is inserted into the processus pterygoideus of the quadrate dorsally.

I describe here the "Caput preorbitale" mentioned above and in this connexion describe the compressor muscle of the orbital glands also. In *Uraeotyphlus*, the compressor muscle makes its appearance as one attached on the internal aspect of the upper portion of the prefrontal and posterior sections reveal the compressor muscle as an internal (circular) and an outer (obliquely longitudinal) portion. A part of this outer portion becomes separated in the region of the optic (*plus* oculomotor) foramen and runs with the M. l. m. internus into the lower jaw where it is inserted. This is the one described by Luther (1914) as "Caput preorbitale". Such a muscle has been noticed in *Ichthyophis* (and also in *Dermophis* according to Norris and Hughes 1918) while in *Caecilia* (Norris and Hughes 1918), the muscle appears to be inserted on the sheath of the compressor muscle or on the lateral wall of the skull. In my sections of *Dermophis gregorii*, the condition is as the one described for *Caecilia*.

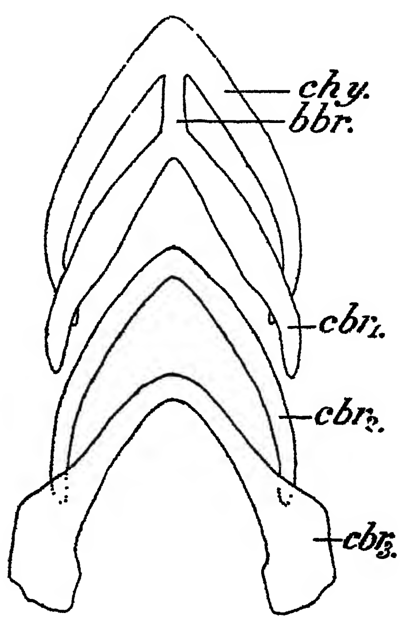
The M. compressor orbitalis has been found in all the Apoda so far studied and the development of the muscle in each case is one of degree; the muscle is extraordinarily well developed in *Herpele*, it is fairly well developed in *Ichthyophis*, *Uraeotyphlus* and *Dermophis* and it is poorly formed in *Scolecomorphus* and *Boulengerula*. The tendon of this muscle arises from the connective tissue covering the optic (*plus* oculomotor) foramen and surrounds the orbital glands. According to Luther (1914) and Edgeworth (1925) the muscle is a modified levator bulbi.

The M. levator mandibulae internus is not noticed uniformly among Apoda. While the muscle is well developed in *Ichthyophis*, *Uraeotyphlus*, *Dermophis*, and *Herpele*, it is absent in *Boulengerula*, *Scolecomorphus* (de Villiers 1938, 1939) and *Geotrypetes* (Norris and Hughes 1918). Consequent on this the path of the maxillary and mandibular branches of the trigeminal also differs. In *Hypogeophis*, *Ichthyophis*, *Uraeotyphlus* and *Herpele*, the maxillary branch runs between the M. l. m. anterior and M. l. m. internus in the region of these muscles, and in *Boulengerula*,

the nerve passes between the M. l. quadrati and the M. l. m. anterior since the M. l. m. internus is absent, while in *Scolecomorphus* where a M. l. quadrati is also absent the ramus maxillaris passes between the M. compressor orbitalis and the M. l. m. anterior. In *Dermophis gregorii*, the same nerve runs internally to the M. l. m. internus portion (*i.e.*, between it and the connective tissue covering of the optic (*plus* oculomotor foramen) which is in close apposition with the M. l. m. anterior and is separated dorsally by a blood vessel. The two muscles cannot be clearly differentiated as in *Ichthyophis*. Probably on account of this fact de Jager (1939) remarks that a M. pseudotemporalis is absent in *D. gregorii* while it is prominently present in *D. mexicanus*.

THE HYOBRANCHIAL SKELETON.

In the adult *Ichthyophis* (Sarasins 1890, M. Fürbringer 1922, de Beer 1937) we notice that in the hyobranchial skeleton, the ceratohyal of either side is fused and is connected with the similarly united ceratobranchial by the first basibranchial, the larval basihyal and second basibranchial having disappeared. [In larval *Ichthyophis* (Sarasinse 1890), *C. tentaculata* (Henle 1839) and *C. hypocyanea* (J. Müller 1835), the fourth ceratobranchial arises as an independent arch and then fuses with the third.] Edgeworth (1935) however, mentions a basibranchial in the hyobranchial skeleton of the larvae of Apoda and also notes the absence of a basihyal in *Siphonops* and *Hypogeophis*. In *Ichthyophis*, there are four ceratobranchials in the adult. In *Hypogeophis* (Gewolf 1923) the ceratohyal of either si deis connected by a U-shaped (Gewolf



TEXT-FIG. 18.—*Uraeotyphlus narayani* Seshachar.

The hyobranchial skeleton *in situ*, ventral view: ×9.
bbr., basibranchial; cbr_1, cbr_2, cbr_3., ceratobranchials 1, 2, and 3; *chy.*, ceratohyal.

basibranchial which meets and fuses with the first pair of ceratobranchials. [Edgeworth (1935) shows the first pair of ceratobranchials disunited ventrally], and with the third ceratobranchial, the fourth and fifth have fused. In *Boulengerula* Peter (1908) draws a figure (Fig. 8) in which the united ceratohyal is mesially in contact with the first ceratobranchial. But my sections show that the ceratohyal and ceratobranchial are united mesially by a basibranchial. In *Uraeotyphlus* (text-fig. 18), *Scolecomorphus*, *Herpele* and *Dermophis*, as in *Boulengerula* and *Ichthyophis*, the ceratohyal (*chy.*) is connected with the ceratobranchial (*cbr*$_1$.) by a basibranchial (*bbr.*) cartilage and there are only three pairs of ceratobranchials (*cbr*$_1$. *cbr*$_2$. *cbr*$_3$.) in all these examples. As in *Ichthyophis*, the ventral ends are mesially united and the dorsal end of the third shows a thickening which probably represents the fused third and fourth. Whether there are one or two basibranchials (copulae 2 and 3) and a single basihyal (copula 1) during developmental stages of *Uraeotyphlus* as in *Ichthyophis*, can only be settled when early developmental stages are procured. The 9 cm. young specimen of *Uraeotyphlus* discloses all the characters of the adult hyobranchial skeleton.

THE CRANIAL NERVES.

The cranial nerves[1] have been described by various authors in several Apodan genera. I have not had access to Fischer's (1843) paper.

Wedersheim (1879) gave a good account of the nerves of *I. glutinosus* and *S. annulatus*. He recorded the following nerves :—

(*a*) Each olfactory nerve is double and comparable with the two roots of a spinal nerve.
(*b*) The optic nerves are vestigial.
(*c*) No mention is made of eye muscle nerves (III. IV and VI).
(*d*) The ophthalmicus profundus V arises independently and an anastomosis between it and ramus maxillaris V is described.
(*e*) There is no ramus palatinus VII, probably it is united with trigeminus. An anastomosis between the facial nerve and gasserian ganglion is recorded.
(*f*) The auditory nerve is well developed and arises by four roots.

Waldschmidt (1887) disagreed with Wiedersheim (1879) in the spinal nerve homology of the olfactory nerve. In *S. annulatus*, he described (Figs. 32 and 33) the following :—

(*a*) The oculomotor sends a branch to compressor muscle and another to the ramus maxillaris V.
(*b*) The trochlear and abducens are absent.
(*c*) A nerve arising from gasserian ganglion is shown to correspond with the ophthalmicus superficialis VII.
(*d*) A nerve considered to be palatinus facialis is described.

Sarasins (1890) mention the double nature of the olfactory nerve and the supply to the organ of Jacobson from the ventral part. The auditory nerve enters the internal ear by five or six orifices.

[1] I am not describing the IX and X nerves for I hope to study these in connexion with the sympathetic system.

Burckhardt (1891) in describing the eye muscles and nerves in *Ichthyophis* noted the absence of the trochlear and abducens nerves like Waldschmidt and Wiedersheim. The organ of Jacobson is innervated by the ventral olfactory nerve and the VIII. IX and X nerves arise by more than one root.

Marcus (1910) described in *Hypogeophis* the presence of all the three eye muscle nerves. The embryo has a lateral line complement, *viz.*, ophthalmicus superficialis. ramus buccalis and ramus mandibularis externus (?). A recurrens VII joins the sympathetic.

By far the most complete account of cranial, spinal and sympathetic nerves was given by Norris and Hughes (1918), we are concerned here with the Section on the cranial nerves only—

(*a*) The olfactory nerves are double; the olfactory glomeruli are arranged in a posterolateral group and an anterior medial and lateral group.

(*b*) The oculomotor, trochlear and abducens nerves are present in *Dermophis, Geotrypetes, Ichthyophis* (the adult *Ichthyophis* is devoid of a trochlearis). In *Herpele* and *Caecilia*. the nerves have completely disappeared.

(*c*) Describing the trigeminal nerve of *Herpele*. a separate profundus ganglion is recorded. The ramus mandibularis gives rise to three branches. (1) a ramulus intermandibularis entering the lower jaw through the pseudoangular. (2) a ramus alveolaris (r. mandibularis internus) which unites with a similarly named nerve of VII and innervates the teeth and the lateral epithelium of the floor of the mouth, and (3) a ramus mandibularis externus which running in the lower jaw innervates the skin. Smaller ramuli from the r. mandibularis V enter into the MM. levator mandibulae anterior l. m. externus, l. m. posterior, and compressor orbitalis.

The ramus maxillaris after passing through the jaw muscles divides into medial and lateral branches. The medial branch sends a commissure to lateral ramus palatinus facialis (temporary union) and also one to medial r. palatinus. While the lateral r. maxillaris supplies the skin at the side of the head, the medial goes to the sheath of the tentacle and the skin of the ventral and ventrolateral surfaces of the snout. In *Geotrypetes*, the r. maxillaris does not divide into lateral and medial branches but there is a branch given off which unites with palatinus VII.

The ramus ophthalmicus profundus arising from the ophthalmic ganglion runs anteriorly and at the level of the choana, a large branch is given off. This branch (op1) supplies the head and the tentacular sheath. A few fibres of this commingle with those of r. maxillaris. A second branch (op3) possibly supplies the Jacobson's gland and primarily the skin on the head. A third branch (op2v) arises from the ventral side of the ophthalmicus profundus (op2) and supplies the ventral epithelium of the snout after some

anastomoses with the branches of medial maxillary V. The principal nerve (op2) goes to the skin of the ventral side of the tip of the snout.

Besides these, a somatic sensory arising from the gasserian ganglion and another sensory (Vd) called the 'dorsal fifth' are also described.

(*d*) The geniculate ganglion though connected with the gasserian can be easily differentiated: four groups of fibres arise from it. The ramus palatinus, after leaving the ganglion and traversing a short distance divides into a medial and lateral branch. The connexions with the r. maxillaris V are described above. The hyomandibular nerve gives rise to a motor branch which enters the depressor mandibular muscle and a visceral sensory which entering the lower jaw as the r. mandibularis internus VII (chorda tympani) unites with the similar branch of the trigeminal and runs to the symphysial region. The r. jugularis proceeds posteriorly after giving off branches to muscles (*viz.*. interhyoideus, constrictor colli). In *Dermophis* and *Geotrypetes* the distribution is the same.

The ramus ophthalmicus superficialis VII arising from the geniculate ganglion courses through the gasserian, anastomosing peripherally with the branches of the r. ophthalmicus profundus and goes to the skin. This is noticed in *Dermophis*, *Herpele* and is absent from *Geotrypetes*.

(*e*) The auditory nerve arises by five roots, four going to the sacculus and the one dorsal to the macula neglecta.

Kuhlenbeck (1922) described the brain of *Ichthyophis*, *Siphonops* and *Hypogeophis*. A rudimentary oculomotorius and double olfactory were recorded.

Englehardt (1924) gave an account of the distribution of the nerves of *Ichthyophis*, but he does not refer to the papers of Norris and Hughes (1918) and Marcus (1910).

(*a*) The trochlear is absent and the rudimentary oculomotor proceeds to rectus and obliquus inferior eye muscles and the abducens to the retractor tentaculi muscle.

(*b*) Of the trigeminal, the ramus nasalis (ophthalmicus profundus) innervates the skin and tentacle sac: the ramus maxillaris innervates the compressor muscle, tentacle and upper jaw. A branch also unites with the facial nerve. The r. mandibularis supplies the masseter, the major and minor temporal muscles and the lower jaw.

The hyomandibularis branch of facial proceeds to the depressor muscle and lower jaw muscles: the fate of r. buccalis is not mentioned and from the r. nasalis (palatinus facialis) a twig joins the gasserian ganglion and another unites with r. maxillaris V. No mention is made of r. mandibularis internus.

de Villiers (1938) described the trigeminal, facial and abducens nerves in *Boulengerula* and *Scolecomorphus*.

(*a*) An abducens is absent from *Boulengerula* but prominently present in *Scolecomorphus*.
(*b*) In *Boulengerula*, there is a commissure connecting the trigeminal and facial ganglia which is absent from *Scolecomorphus*; only in *Boulengerula*, the ophthalmicus profundus ganglion is separated from maxillo-mandibular ganglion.
(*c*) The palatinus facialis stops short at the sensory ganglion of trigeminal in *Boulengerula* and in *Scolecomorphus* the r. palatinus which runs anteriorly receives a branch from maxillary V: the distribution of hyomandibularis VII is not described and in both genera, a chorda tympani is wanting.

de Jager (1939) did not add anything new to what has already been described by Norris and Hughes (1918) but differed in certain important points. She recorded in *D. mexicanus* the following :—

(*a*) The geniculate and gasserian ganglia overlap but do not fuse.
(*b*) There are two prootic foramina,—a dorsal for r. maxillo-mandibularis and a ventral for ophthalmic branch. The r. ophthalmicus profundus has its own ganglion.
(*c*) A temporary anastomosis of r. palatinus with ophthalmicus profundus in the profundus ganglion is recorded on one side.
(*d*) The presence of an anastomosis between maxillary V and palatinus facialis is noted.
(*e*) An abducens is absent; no mention is made of oculomotor and trochlear nerves.
(*f*) A branch from maxillary V innervates the compressor muscle of the orbital gland.

The olfactory nerve.—The double nature of the nerve has been noticed from a long time. The ventral division is the shorter of the two and we may briefly examine the passage of these nerves in *U. narayani*. Arising from the olfactory lobe, each pair (right dorsal and ventral, and left dorsal and ventral) traverses independently in a canal in the sphenethmoid bone and soon however. the right ventral gives rise to a ramulus which passes craniad in a separate canal. Anteriorly the larger ventral olfactory nerve emerges from the bony canal (text-fig. 9, *von.*) and proceeds to innervate the medial and lateral divisions of the "Nebennase" (*see* Olfactory organ) and also its glands. At the region the innervation of the "Nebennase" is noticed, the median unpaired ramulus (*von*$_b$.) of the right olfactory nerve also gains exit and proceeds to the right side to innervate the ventral olfactory epithelium. In all the series of the head of *Uraeotyphlus*, this feature is noticed.

The dorsal olfactory nerve also gains exit from the sphenethmoidal bony canal and runs in close approximation with the ophthalmicus profundus V (with no anastomoses) and distributes itself over the olfactory epithelium.

In *Herpele*, my slides show the right and left ventral olfactory before entering the ventral canals in the sphenethmoidal septum, each gives rise to a small and a large ramulus respectively. These also run in independent canals in the septum and emerge in the region of the "Nebennase" to supply the right and left olfactory epithelium. This feature however, is not recorded by Norris and Hughes (1918). In *Dermophis* the supply of the "Organ of Jacobson" and "olfactory epithelium covering the convexity of the ridge on the floor of the olfactory chamber" by the ventral olfactory nerve as recorded by Norris and Hughes is corroborated by me. The extra branch seen in *Uraeotyphlus* and *Herpele* is not present.

The optic and eye muscle nerves.—There is considerable difference of opinion with regard to the optic and eye muscle nerves among Apoda. Norris and Hughes review the previous literature on the subject like that of Waldschmidt (1887) on *S. annulatus*, Burckhardt (1891) on *I. glutinosus* and Marcus (1910) on *H. rostratus*. The observations of Norris and Hughes (1918) may briefly be summarised as follows :—

(*a*) An optic nerve is noticed in *Dermophis*, *Geotrypetes* and in the adult *Ichthyophis*.

(*b*) Of the eye muscle nerves, oculomotorius is noticed in *Dermophis* (vestigial), *Geotrypetes* and *Ichthyophis* (very vestigial), a trochlear is present in *Dermophis* (vestigial), *Geotrypetes* (vestigial) and absent from *Ichthyophis* ; an abducens is noticed in *Dermophis* (large), *Geotrypetes* and *Ichthyophis*. It innervates the tentacular muscle. In *Herpele* and *Caecilia*, these nerves are absent except the abducens which innervates the M. retractor tentaculi.

Englehardt (1924) in describing the tentacle and eye of *I. glutinosus* confirmed the presence of an abducens nerve (going to the tentacle), of an oculomotor (innervating the rectus and obliquus inferior) and the absence of a trochlear.

de Villiers (1938) noted the presence of an abducens in *Scolecomorphus* while its absence was recorded in *Boulengerula*.

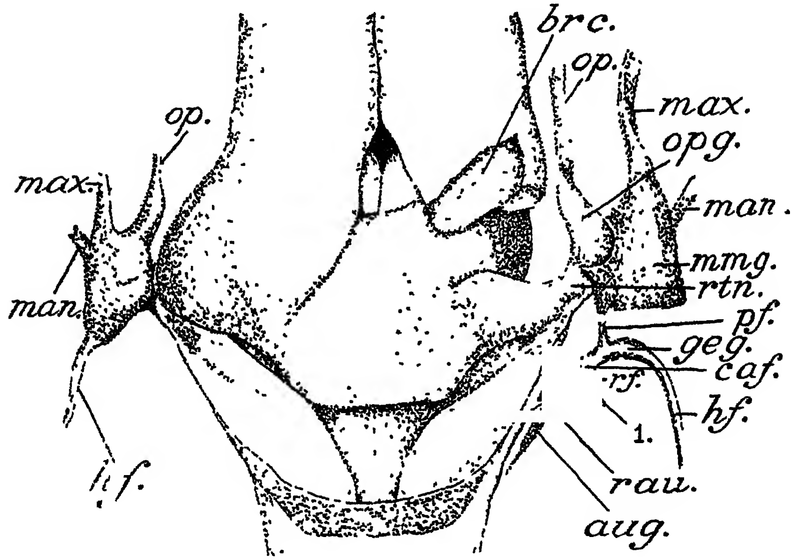
de Jager (1939) working on *D. mexicanus* and *D. gregorii* recorded that "All the eyemuscles and nerves have degenerated, except the M. rectus externus" and that an abducens was not recognizable.

In *U. narayani*, the optic nerve is well developed. The photomicrograph (Pl. VI, fig. 6) shows the optic nerve. Both in the juvenile and in the adult, the oculomotor is so vestigial that it could be found only with difficulty. The trochlear is definitely absent. The abducens is a powerful nerve and innervates the M. retractor tentaculi.

The trigeminal nerve.—As the descriptions of later authors like Englehardt (1924), de Villiers (1938) and de Jager (1939) vary considerably from those of Norris and Hughes (1918), I propose to describe in brief the passage and division of these nerves making relevant references to the above authors where necessary. It will be noticed that the observations of Norris and Hughes are almost completely borne out by my studies.

The gasserian ganglion (text-fig. 19) in *U. narayani* is seen externally to the os Basale (prootic region) and while the posterior part of

the ganglion (*mmg.*) gives rise to the maxillary (*max.*) and the mandibular (*man.*) branches, the anterior portion (*opg.*) gives rise to the oph-



TEXT-FIG. 19.—*Uraeotyphlus narayani* Seshachar.

A part of brain showing the origin of trigeminal, facial and auditory nerves. On the right side a portion of the hemisphere is cut and the structures are stretched a little : ×24.

aug., auditory ganglion ; *brc.*, brain cut to show the root of trigeminal nerve ; *caf.*, commissure between auditory and facial nerves ; *geg.*, geniculate ganglion ; *hf.*, r. hyomandibularis facialis ; *man.*, r. mandibularis V ; *max.*, r. maxillaris V ; *mmg.*, maxillo-mandibular part of gasserian ganglion ; *op.*, r. ophthalmicus profundus V ; *opg.*, ophthalmicus profundus part of gasserian ganglion ; *pf.*, r. palatinus facialis ; *rau.*, root of auditory nerve ; *rf.*, root of facial nerve ; *rtn.*, root of trigeminal nerve ; *1.*, utricular nerve.

thalmicus profundus (*op.*) nerve. The ophthalmicus profundus ganglion is separate from the maxillo-mandibular part though closely apposed to it.

The ramus mandibularis V.—The disposition of the mandibular branch of the trigeminal in *Uraeotyphlus* follows the description given for the same by Norris and Hughes (1918). Arising from the maxillo-mandibular part of the gasserian ganglion (text-fig. 19, *mmg.*) it passes through a notch in the quadrate bone and then internally to M. levator mandibulae externus into the lower jaw through a foramen in the pseudo-angular bone. In the jaw, three branches can be followed. A branch,—ramulus intermandibularis to supply the intermandibular muscle and the skin, a r. mandibularis internus (alveolaris) which unites with a similarly named nerve of the facial, and a main branch,—r. mandibularis externus (composed of two divisions) which run between the speudo-angular and the pseudodentary and then in a canal in the latter to the symphysial region. Further, before proceeding to the lower jaw the r. mandibularis gives off small twigs which innervate the lateral skin passing through squamosal (Pl. V, fig. 5, $v_3ls.$) and the MM. l. m. anterior, l. m. externus ($v_3me.$), l. m. posterior and the compressor

orbitalis ($v_3cpc.$). The united mandibulae internus nerve (mandibulae internus V *plus* chorda tympani) also runs anteriorly; a ramulus of this is noticed to enter the region near the sublingual glands but not into the tongue as de Jager (1939) records in *Dermophis* where the nerve leaves the symphysial region to supply the epithelium of the floor of the mouth and the muscles of the tongue as in the higher tetrapodous forms and the latter point is also not recorded by Norris and Hughes (1918). Branches of the external mandibular enter the skin. I have examined the young specimen of *Uraeotyphlus* also and the above description drawn from this and the adults closely corresponds with that of Norris and Hughes.

In *Ichthyophis* larvae however, as described by Norris and Hughes (1918), the r. mandibularis externus runs externally to the jaw along with the r. mentalis externus VII. Englehardt (1924) recorded that the r. mandibularis innervated the masseter (Vc1), temporalis major (Vc2), temporalis minor and the lower jaw (Vc3). No mention is made of the branches that enter into the lower jaw.

The ramus maxillaris V.—Leaving the maxillomandibular part of the gasserian ganglion (text-fig. 19, *mmg.*), the nerve is first noticed associated dorsally with a branch (Pl. V, fig. 5, *os.*) between the MM. l. quadrati and l. m. anterior. More anteriorly the maxillary branch separates itself from this ramulus and runs between the MM. l. m. internus and l. m. anterior. Before running between these two muscles, and while through them, small ramuli are given off, the first of which unites anteriorly below the M. compressor orbitalis with the medial branch of palatinus facialis. This anastomosis is anterior to the temporary one between the lateral palatinus facialis and maxillary V. The principal maxillary branch now divides into two (text-figs. 3. 9, $max_1.$, $max_{2b}.$) which are enclosed anteriorly in a canal in the maxillopalatine bone (text-fig. 3, *map.*). Below the tentacular canal, the two branches of the maxillary are still enclosed in the bone but far apart in individual canals. The lateral branch (text-fig. 9, $max_{2b}.$) distributes itself to the side while the bigger inner branch running anteriorly (text-fig. 8, $max_{1b}.$) supplies the tentacular region.

In *Ichthyophis*, the maxillary branch has its lateral ramus (max_2) as its main component, while the median ($max_1.$) unites with the median palatine ($pal_1.$) branch. A lateral palatine branch ($pal_2.$) unites temporarily, a feature also noticed in *Herpele* (Norris and Hughes 1918). In *Dermophis* (Norris and Hughes 1918) the arrangement of the maxillary nerve is as in *Herpele*. In *Geotrypetes* the maxillary does not divide into medial and lateral branches but a branch from it joins palatinus facialis. A double anastomosis of palatine and maxillary occurs. A united branch from maxillary and mandibular passes to the M. compressor orbitalis. Englehardt (1924) noted in *Ichthyophis* that the maxillary V innervated the compressor muscle (Vb4), skin (Vb1, Vb2), tentacle (Vb6) and upper jaw (Vb6); an anastomosis with r. buccalis facialis (Vb3 *plus* VIIa2) and a branch (Vb5) to r. nasalis facialis are also recorded. De Jager (1939) described a twig from the maxillary V to the compressor muscle in *Dermophis*, a point also corroborated by me.

The ramus ophthalmicus profundus V.—Having differentiated (text-figs. 11, 19, *rop. op.*) from the inner aspect of the profundus ganglion (text-fig. 19, *opg.*), it runs anteriorly surrounded by the ganglion, a few fibres of which enter the r. palatinus facialis. Running by the side of the pleurosphenoid more towards the orbital cartilage, it gives off a branch (op_1.) and in the choanal region the main branch (*op.*) is enclosed in a canal (*see* text-fig. 6, *sphe.*), then in a groove in the sphenethmoid bone while the branch (op_1.) occupies a dorsal position. It (op_1.) runs anteriorly after giving off a large branch which enclosed in the frontal bone (*see* text-figs. 3. 9. op_{1b}.) supplies the dorsal skin and this does not establish any connexion with ophthalmicus superficialis VII as described by Norris and Hughes (1918); the other is then enclosed in the dorsal part of the tentacular canal in the maxillopalatine bone (text-fig. 9, op_1.) and supplies the tentacular region. This ramulus (op_1.) closely corresponds with (op_1.) of Norris and Hughes. A second branch (op_2.) arises from the ophthalmicus profundus during its passage in the canal and the main branch (*see* text-figs. 3, 9, *op.*) and the second (*see* text-figs. 1, 3, 9, op_2.) run below the sphenethmoid roof-like extension. This latter ramulus runs in the roof of the nasal chamber near the "Nebennase" but does not supply any fibres to the glands of the latter (though Norris and Hughes describe so) but proceeds to innervate the side after passing through a foramen (f. epiphaniale ?) in the septomaxilla. The branch (op_3.) of Norris and Hughes's description tallies with this. A third (op_3.) and a fourth (op_4.) branches are given off from the ophthalmicus profundus. These two branches lie near the dorsal olfactory nerve. Branch (op_3.) (*see* ~~text-fig.~~ 1, op_{3b}.) runs for a short distance below the nasal bone and then passes through it for the dorsal skin. The fourth branch (*see* text-figs. 1, 8, op_4.) passes downwards by the side of the septum nasi and then through the prevomer for the innervation of the floor of the upper jaw and this branch is comparable with (op2v) of Norris and Hughes. The principal branch (*op.*) runs in a canal in the nasal bone and proceeds after passing through a foramen (f. apicale ?) in the premaxilla for the innervation of the snout region giving off during its course a large number of twigs dorsally (*see* text-fig. 1, *ops.*).

Englehardt (1924) described the ophthalmicus profundus V in *Ichthyophis* as r. nasalis trigeminus from which branches proceeded to skin (Va1), tentacle sac (Va2) and to the snout (Va3, Va4).

In Urodela, the ophthalmicus profundus divides into a minor, a ventral, a lateral and a median branch and the latter two gain exit through the foramina epiphaniale and apicale respectively for the innervation of the snout region. However, it is difficult to recognise similar branches clearly in Apoda and at any rate, in their figure 7q, Marcus, Stimmelmayr and Porsch (1935) indicate the two foramina apparently believing them to be for the two branches of the profundus nerve. Norris and Hughes (1918) while making no mention of the probable comparison with the Urodelan median (nasalis internus) branch, notes that their (op2v) and (op1 partly) are comparable with the ventral and lateral Urodelan branches respectively. However, it is just possible that the branches (op_1.. partly), (*op.*), (op_2.) and (op_4.) of

Uraeotyphlus may find comparison with the ophthalmicus profundus minor, nasalis internus, nasalis externus and ventral branches of Urodela.

The facial nerve.—The facial nerve takes its exit through a separate foramen,—the facial foramen (*see* text-fig. 6, *ff.*) in the lateral wall, *i.e.*, the prootic portion of the os Basale. The prootic (*prof.*) and facial foramina are separated by a bony prefacial commissure (*pfc*). The geniculate ganglion (text-fig. 19, *gcg.*) is small and extracranial and is separate from gasserian ganglion in the adult[1] while in the young stage examined, the ganglia are united.

No connexion between the gasserian and geniculate ganglia has been shown by Englehardt (1924) in *Ichthyophis*.

The ramus palatinus VII.—The palatine branch arising from the geniculate ganglion enters through the palatine foramen, the palatine canal[2] (*see* text-fig. 6. *pca.*) and then runs in association with the carotid artery in the carotid canal and emerges finally with the carotid artery into the cranioquadrate passage from the carotico-palatine foramen (in fig. 6, the bristle enters through the carotid foramen and comes out through the carotico-palatine foramen). The palatine nerve occupies a position below the profundus ganglion which is situated anteriorly and this is maintained till the ophthalmicus profundus is differentiated when a few fibres from the latter enter into the palatine (Pl. V., fig. 5). This anastomosis is an important feature for in no apodan form studied so far, a nervous connexion between the two is described, though de Jager (1939) makes mention of such an anastomosis in *Dermophis* on one side only. In Urodela and Anura, this anastomosis commonly occurs. In the region of the tentacular muscle, the ramus palatinus in *Uraeotyphlus* is separated from the ophthalmic branch by this muscle. The palatine anteriorly divides into a median (*see* text-fig. 10, pf_1.) and a lateral branch (pf_2.). A small twig arising from the maxillary branch of trigeminal meets temporarily the lateral palatine branch ; more anteriorly, another division of maxillary fuses with the median palatine. The composite palatine branch ($pf_1 max_b$.) runs in the choana region while the lateral palatine (pf_2.) runs dorsally and then ventrally to the maxillopalatine (*see* text-figs. 8, 9, pf_2.) to the anterior region. The anastomoses between the palatinus facialis and maxillary V are noticed only in Anura. The further distribution of the ramuli of these is as described by Norris and Hughes (1918) *i.e.*, (pf_2.) to choanal epithelium and maxillary teeth and ($pf_1 max_b$.) to medial wall of choana, roof of mouth and vomerine teeth.

In *Ichthyophis*, *Scolecomorphus*, *Boulengerula* and *Herpele* the palatine nerve first runs in the palatine canal of os Basale and then assumes the usual condition. This feature of the passage of the palatine in the os Basale for a short distance is not noticed in other examples *viz.*, *Dermophis*, *Caecilia* and *Geotrypetes* (Norris and Hughes 1918).

A minute ganglion at the junction of the lateral branch of the palatine with the maxillary V is described in *Dermophis*, larva of *Ichthyo-*

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[1] This seems to be a variable factor, for in an adult individual while on one side there is a connection between the extracranial facial and gasserian ganglia, no connection is noticed on the other side.

[2] This may be a canal or a groove in *Uraeotyphlus*; further the palatine branch on one side does not enter the palatine canal in one of the specimens studied.

phis and *Herpele.* I have not been able to detect a similar ganglion in adult *Uraeotyphlus* and in *Geotrypetes* it is apparently absent according to Norris and Hughes (1918). In the young stage of *Uraeotyphlus* that I have examined, it is noticed that the lateral branch (pf_2.) before it receives a branch from the maxillary V (max_b.) enlarges into a ganglion,- the palatine ganglion. Obviously this is purely a larval feature for, in both *Ichthyophis* and *Uraeotyphlus* larvae the ganglion is noticed while in the adult it has disappeared. The same is probably the case in *Geotrypetes* where the adult lacks one.

Englehardt (1924) noted that a twig (VIIa1) connected ramus palatinus with gasserian ganglion ; the division of the palatine was not noticed. A connexion with maxillary V (Vb3 *plus* VIIa2) by ramus buccalis facialis and the more anterior union of r. nasalis facialis (palatinus facialis) with a branch of maxillary (Vb5) have also been recorded.

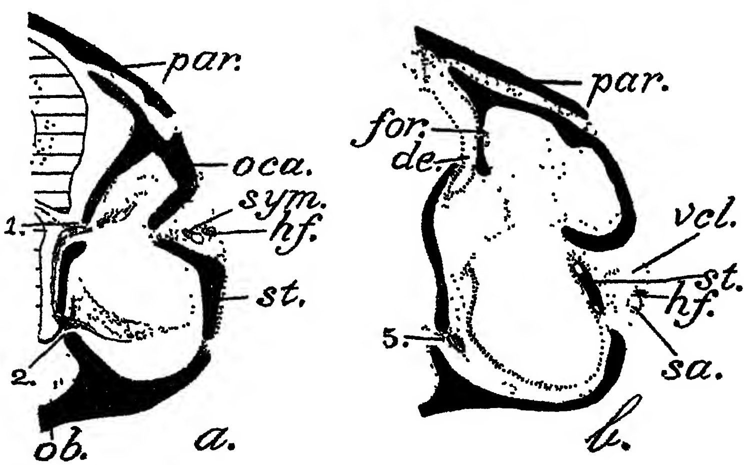
The ramus hyomandibularis VII.--After the separation of the palatine branch, the ramus hyomandibularis (text-fig. 19, *hf.*) arises from the geniculate ganglion (*gcg.*) and runs posteriorly and dorsally to the stapes (*see* text-figs. 7*a*, *b*. *hf.*). The first branch given off from the geniculate ganglion uniting with the sympathetic fibres of the gasserian runs posteriorly by the side of the otic capsule in association with the r. hyomandibularis. A slender nerve is now given off from the r. hyomandibularis which running between the MM. depressor mandibulae and l. m. posterior enters a canal in the lower jaw as the ramus alveolaris (chorda tympani) in association with the r. mandibularis internus V. A bigger third proceeds to innervate the M. depressor mandibulae. The main branch,—r. jugularis runs posteriorly supplying the muscles in its course.

In *Ichthyophis* larva a mentalis externus, a jugularis and a third branch which divides into mentalis internus and an alveolaris are described by Norris and Hughes (1918). In the adult, the r. alveolaris arises independently. The origin therefore, of the chorda tympani from the hyomandibular branch in *Uraeotyphlus* differs from that in *Ichthyophis*. In *Dermophis* and *Herpele* (Norris and Hughes 1918), a ramus jugularis is described and it innervates the interhyoideus and constrictor colli muscles as in *Ichthyophis* and *Uraeotyphlus*. In *Geotrypetes* also there is a jugular branch. However, in the descriptions of the cranial nerves of *Dermophis* (*D. mexicanus* and *D. gregorii*) the fate of the hyomandibular is differently described by de Jager (1939). After giving off the r. alveolaris, the hyomandibular divides into three ramuli ; the first innervates the M. depressor mandibulae (M. cephalodorsomaxillaris) while the other two are " ultimately lost amongst the branches of IX and X..". No reference is made to the jugularis branch. Englehardt (1924) described three branches (VIIb1, VIIb2, VIIb3) of the hyomandibular but their destination has been incompletely noted as MM. depressor and mylohyoideus.

The ramus ophthalmicus superficialis VII.—At the region of the differentiation of r. mandibularis V, the fibres of the ramus which in its topographical disposition corresponds with what has been described as " ophthalmicus superficialis " by Norris and Hughes (1918) can be made out in the maxillomandibular part of the gasserian ganglion.

Anteriorly, this nerve is disposed dorsally to the maxillary branch (Pl. V fig. 5. *max.*) and is located between the MM. l. quadrati and l m anterior and more anteriorly between the MM. l m. internus and l. m anterior (*os.*) It divides into two: the dorsal branch ends in the M. l m. anterior while the ventral passes dorsally to the muscle and supplies the skin. No motor branch is described by Norris and Hughes (1918) and the anastomosis between branch (op_1.) of ophthalmicus profundus and ophthalmicus superficialis VII is also not seen by me.

The auditory nerve.—In *Uraeotyphlus* posterior to the prefacial commissure, the auditory nerve is met with, a part of which is in union with the fibres of the seventh nerve (text-fig. 19, *caf.*). The auditory ganglion (*aug.*) is rather thin and from it ramuli run into the internal ear through the bony septum. The number of ramuli may vary in the same individual as, *e.g.*, in *Ichthyophis* and *Uraeotyphlus*. it may be five or six. In all the Apoda so far examined, the first ramulus supplies the utricular part (text-fig. 19, *1*) while the remaining innervate the saccular portion. In *Uraeotyphlus*, the fourth ramulus enters the saccular part (*see* text-fig. 7*d*, *4*) in the region of the endolymphatic foramen which is situated dorsally. Figure 7*e* is posterior to the endolymphatic foramen. Two figures (20*a* and 20*b*) are drawn for *Dermophis* to show two ramuli entering in at the same region to the utri-



TEXT-FIG. 20.—*Dermophis gregorii* Boulenger.

Two consecutive transverse sections in the auditory region: ×33.

de., ductus endolymphaticus; *for.*, foramen in the bony septum; *hf.*, r. hyomandibularis facialis; *ob.*, os Basale; *oca.*, otic capsule; *par.*, parietal; *sa.*, stapedial artery; *st.*, stapes; *sym.*, sympathetic nerve; *vcl.*, vena capitis lateralis; *1*, *2*, *5*., auditory orifice for the utricular (1) and saccular nerves.

cular and saccular portions (Fig. 20*a*, *1*, *2*) respectively and further. foramen 5 (text-fig. 20*b*, *5*) is noticed along with the dorsal endolymphatic foramen. While de Jager (1939) has recorded only four ramuli in *Dermophis*, I notice five, of which four innervate the saccular portion. There is one other interesting point in the endolymphatic region of the ear of *Dermophis*. There is a foramen (text-fig. 20*b*, *for.*) in the

septum dorsally to the endolymphatic foramen through which the epithelium of the endolymphatic canal is in contact with the semicircular canal of the internal ear. I am unable to say at present what exactly is the significance of this. In *Scolecomorphus*, four or five ramuli are noticed. In *Boulengerula*, there are again five and the endolymphatic foramen is between the third and fourth. In *Siphonops*. Wiedersheim (1879) recorded only four foramina.

The cranial nerves of *Boulengerula* and *Scolecomorphus*.

I shall consider the cranial nerves of the two African genera *Boulengerula* and *Scolecomorphus* together and remark only on the salient features noticed in them.

The intracranial connexion between the geniculate and the gasserian ganglia and in the latter the separate existence of ophthalmicus profundus and maxillo-mandibular parts are known in *Boulengerula*; in *Scolecomorphus* the two ganglia (trigeminal and facial) are connected extracranially and the gasserian ganglion is a composite one.

In Figs. 6*a*, 6*b* and 6*c* drawn by de Villiers (1938) for *Scolecomorphus*, the origin of the trigeminal nerve is clearly shown. However, I have not been able to make out a "ganglion palatinum" in my sections of *Scolecomorphus*.

The first branch to separate itself off from the gasserian ganglion is the ramus mandibularis in *Scolecomorphus* and *Boulengerula*. A ramus mandibularis internus enters the lower jaw and unites with the chorda tympani where a few ganglion cells are noticed (*Boulengerula*). However, de Villiers (1938) denied the existence of a chorda tympani in these two genera. The united branch supplies the skin and tongue muscles in *Boulengerula*. Peculiarly in *Boulengerula* a ramus mandibularis externus is absent, while in *Scolecomorphus* it is prominently present.

There is a ramulus going to the compressor muscle from the ramus maxillaris in both genera; in *Boulengerula*, the r. maxillaris divides into a lateral and a larger medial one and from the latter there is a palatine commissure. In *Scolecomorphus*, the r. maxillaris sends first a palatine commissure and then a small ramulus to innervate the side (comparable with the lateral palatine branch) and the principal branch becomes ventrally disposed to the maxillopalatine and proceeds to the tentacular region.

There are only three branches of the ophthalmicus profundus in *Boulengerula*. The first, running for a short distance in the frontal bone supplies the dorsal skin; a second branch running lateroventrally and gaining exit through the nasopremaxilla-maxillopalatine supplies the anterior skin. The third or the principal branch is enclosed in the nasal portion and distributes itself to the snout. In *Scolecomorphus*, the first branch passes through the frontal as in *Boulengerula*; the second running dorsally to the orbital glands gets exit through the prefrontal; a third innervates the lateral and the tentacular region after passing through the septomaxilla. The fourth running by the side of the septum passes through the prevomer and premaxilla to the snout. The principal branch also innervates the snout.

The facial nerve.—A bony prefacial commissure is present in both genera. The r. palatinus runs for a short distance in the palatine canal in *Boulengerula* and anteriorly the r. palatinus is situated below the ophthalmicus profundus ganglion as in Fig. 8 drawn by de Villiers (1936, p. 237) though his labellings 'em' and 'bVl' should be read as M. retractor tentaculi (instead of eye muscle) and palatinus facialis (instead of branch of ophthalmicus profundus) respectively. The palatine nerve does not divide into lateral and medial branches but however, receives a branch from the r. maxillaris V. De Villiers denied the presence of a palatine branch in *Boulengerula* and in a later paper also he (1938, p. 19) recorded that "The palatine of VII stops short at the sensory ganglion of V in all the four sides available for comparison", and shew no palatine in Fig. 8 (1936, p. 237) or in Fig. 3 (1938, p. 11) and reaffirmed this on page 24 (1938) by saying that the facial has only one branch and, *i.e.*.—the hyomandibular. In *Scolecomorphus*, there is only one maxillo-palatine anastomosis and the undivided r. palatinus proceeds through the prevomer to the snout.

It must be remarked here that no anastomosis between the ophthalmicus profundus V and r. palatinus occurs in *Scolecomorphus*, though the profundus ganglion is not distinct from the gasserian ganglion.

KINETISM.

I only review in brief the problem of kinetism in Apoda here. The autostylic and mostly monimostylic condition of the cranium noticed in Amphibia was considered primary by K. Fürbringer (1904) who derived it from a Dipnoan one. Later Versluys (1912) who discovered the M. levator quadrati in Apoda described the streptostyly noticed among the members of this group as primitive and Luther developed this line. The latter author (1914, p. 12) in homologising the M. l. quadrati with the M. constrictor dorsalis I of fishes came to the same conclusion as Versluys and if however, this condition is derived from the monimostylic Urodela, then the presence of M. l. quadrati becomes questionable.

Edgeworth (1925) after studying a few developmental stages of *I. glutinosus* and a *Siphonops* larva added that the processus ascendens of the quadrate is fused with the orbital cartilage in early stages in *I. glutinosus* and in *Siphonops* "there is a cartilaginous continuity between the quadrate and the lateral process of the basal plate" besides mentioning other points of contact between the chondrocranium and quadrate. Thus he comes to the conclusion that (p. 237) "These phenomena suggest that the streptostylic condition of adult Gymnophiona is not primary, but secondary to an original monimostylic one. The contrary opinion fails to explain the above described structures". It has been pointed out by de Beer (1937) in this connexion that the terms streptostylism and monimostylism are applicable to adult and not larval crania. Obviously, Edgeworth does not take into consideration the observation of Peter[1] (1898) where no processus ascendens connection with orbital cartilage is reported.

[1] Edgeworth mentions that his embryo is younger than the one modelled by Peter and therefore if the latter author had studied the same stage as Edgeworth, it may be surmised that the connection might have been discovered.

According to Marcus, the streptostyly of the Apoda is an ancestral acquisition and in this connexion Marcus, Stimmelmayr and Porsch (1935. pp. 418. 419) point out:—

> Heute bin ich überzeugt, dass dem Chondrocranium keine ausschlaggebende Bedeutung fur derartig weitgehende Hypothesen zuzusprechen ist, da temporar Verwachsungen vorkommen, die wieder gelöst werden, so dass jeder sich aussuchen kann, was er für seine Hypothese braucht.

Hueber (1933) described the kinetism in the skull of *Hypogeophis* in detail while pointing out at the same time the primary or secondary nature of the stylism has not engaged his attention. It is recorded that the two segments,—the basal composed of the os Basale and the quadrate comprising the other bones move on each other; the skull is, therefore, amphikinetic. But Luther (1914) and Lakjer (1927) consider the Apodan skull to be mesokinetic. De Beer (1937) while accepting that the skull of *Hypogeophis* is kinetic in Versluys's sense and is "capable of certain amount of internal movement although the quadrate is fixed to the squamosal" pointed out that the skull must be classified as monimostylic on Stannius's scheme. No doubt the quadrate is firmly bound to the internal aspect of the squamosal, but is certainly capable of some movement and is always separated by a certain amount of connective tissue. The quadrate is never *fused* with squamosal. contrary to what de Beer (p. 126) mentions in the case of *Hypogeophis*. In fact, no Apodan example so far studied is typically monimostylic, all of them being strictly streptostylic. Marcus, Stimmelmayr and Porsch (1935) confirm this when they say (p. 417) that in *Hypogeophis* 'Der Schädel ist hyostyl und streptostyl'. Luther (1914) also mentions that the movement of the quadrate is considerably lessened but is not completely lost.

Hueber (1933) while mentioning that the connective tissue between the bones acts as a cushion during burrowing noted however. that since the bones are so closely bound the movement between the bones in a streptostylic sense may not be possible thus implying a functional monimostyly. Stadtmüller (1936) also noted that since the Apodan quadrate was united with squamosal (syndesmotically) or pterygoid. it exhibited "sympektische monimostyly". De Villiers (1938) also mentioned that no movement was possible between quadrate and squamosal and therefore, the quadrate was monimostylic. In all these cases, it is difficult to say if no movement is possible between the quadrate and squamosal; so long as they are not *fused*, a certain mobility can be expected and as Luther remarks it is only a question of degree. Thus according to me, it is correct to assume that there is not even functional monimostyly and therefore, they are typically streptostylic and kinetic unlike what de Beer (1937) shows in his table on page 426.

According to Hueber (1933) in *Hypogeophis*, the movements of the quadrate and basal segments are possible at these four points:

(1) processus columellaris (processus oticus) of the quadrate and the stapes (columella),

(2) processus cultriformis (rostrum) of the os Basale and the prevomers,

(3) processus pterygoideus of the quadrate and the basipterygoid process, and
(4) os Basale and the parietals.

Of the Apodan genera examined by me none possesses all these four kinetic points. In *Ichthyophis* and *Uraeotyphlus,* the processus pterygoideus of the quadrate and the basipterygoid process are syndesmotically united; in *Scolecomorphus*, a stapes is wanting and therefore, a quadratostapedial articulation is lost though there is a processus oticus; in *Dermophis* (de Jager), the processus oticus and stapedial process are united and therefore, the movement is lost. The significance of the loss of kinetism is that the Apodan skull is slowly becoming akinetic.

SUMMARY AND CONCLUSION.

Summary.—The study of cranial morphology of *Uraeotyphlus* shows certain features in which it differs from its South Indian congener *Ichthyophis*, thereby amply supporting Peters's treatment of *Uraeotyphlus* as a separate genus. The anterior disposition of the tentacle, the absence of an external tentacular fold and the zygokrotaphic condition of the cranium have already been noticed by Peters and other workers.

The new facts which the present study reveals are largely a set of negative features by which *Uraeotyphlus* could be differentiated from *Ichthyophis* and they are:

(1) The absence of an eminentia olfactoria in *Uraeotyphlus* and therefore the opening of the secondary nose ("Nebennase") more towards the nasal septum.
(2) The absence of a passage in the stapes of *Uraeotyphlus* for the stapedial artery.
(3) The absence of a buccal branch of facial nerve in *Uraeotyphlus* and in the young stage examined, the r. mentalis externus VII and r. mandibularis externus V do not run outside the jaw. The origin of the chorda tympani (r. alveolaris VII) is different; while it arises independently from the ganglion in *Ichthyophis,* it is a branch from the hyomandibular nerve in *Uraeotyphlus.*
(4) The uniform occurrence of an anastomosis between the ophthalmicus profundus ganglion and the r. palatinus facialis in *Uraeotyphlus.* This is an important feature for Norris and Hughes describe that in all Caeciliae, on account of the distinctness of the profundus ganglion from the rest of the gasserian, the palatine anastomosis is transferred from the profundus to the maxillary branch. In *Uraeotyphlus,* the profundus is no doubt a distinct ganglion but possesses both palatino-profundus and palatino-maxillary anastomoses.
(5) The highly abbreviated embryonic and larval periods and the appearance of adult characters very early in larval life if not in the embryos of *Uraeotyphlus.*
(6) The shape of the skull; triangular in both *Ichthyophis* and *Uraeotyphlus* but in the latter the apex is more pointed than in *Uraeotyphlus.*

Now, the other important points in the study of the cranial morphology of *Scolecomorphus, Boulengerula, Dermophis, Herpele* and *Uraeotyphlus* may be recounted:

(1) In *Ichthyophis* and *Uraeotyphlus*, there is a syndesmotic connexion between the basipterygoid process and processus pterygoideus of the quadrate. In *Scolecomorphus* anterior to the palatobasal articulation there is a thick connective tissue strand running from the processus ascendens of the quadrate to the cartilaginous facet of the basipterygoid process; from the same certilaginous facet arises the M. levator mandibulae posterior instead of from the ventral aspect of the processus pterygoideus. Thus in *Scolecomorphus*, while one kinetic muscle (l. quadrati) is absent, the other (l. m. posterior) extends between the basipterygoid process and the lower jaw instead of between the processus pterygoideus and the lower jaw.

(2) In *Boulengerula*, the stapedial artery passes through a passage in the stapes.

(3) In *Scolecomorphus*, there is a well developed eminentia olfactoria and *Uraeotyphlus* and *Boulengerula* lack it.

(4) *Ichthyophis* skulls exhibit both crescentic and circular postfrontals; while in those with crescentic postfrontal, the prefrontal and septomaxilla may be separated by the approximation of nasal and maxillopalatine, in those with circular postfrontals, the prefrontal and septomaxilla are always apposed. In *Uraeotyphlus*, the circular postfrontal characterises the adult and the prefrontal and septomaxilla are always separated.

(5) The number of acustic foramina range from four to six; in *Boulengerula*, *Scolecomorphus* and *Dermophis*, it may be four or five (de Jager describes only four in *Dermophis*) and in *Uraeotyphlus*, it may be five or six. While the stapes with its footplate is well developed in Apoda, *Scolecomorphus* is the only one to lack it. It is thought (Versluys) that the squamoso-quadrate complex transmits vibrations to the internal ear through the stapes, in which case *Scolecomorphus* even with four or five acustic innervation, is probably deaf.

(6) The processus condyloides of the lower jaw is well developed in *Ichthyophis* and *Uraeotyphlus*, feeble in *Herpele*, *Dermophis* and *Scolecomorphus* and absent from *Boulengerula*.

(7) The degenerate eye is hidden under the squamosal in *Boulengerula* while in *Scolecomorphus* it is directed towards the lower jaw and is not hidden contrary to the descriptions of Nieden and de Villiers.

(8) Eye muscles are absent in *Boulengerula* and *Scolecomorphus*. In *Dermophis*, eye muscles and optic nerve are well developed contrary to the observations of de Jager. A M. rectus internus is described in *Dermophis* which was denied by Norris and Hughes.

(9) The double appearance of retractor tentaculi muscle is noticed in *I. monochrous*, *Dermophis*. *Uraeotyphlus* and *Boulengerula*. In *Scolecomorphus* anteriorly the retractor is partly inserted into the tentacle and partly into the tentacular fold.

(10) There is only genioglossus muscle in the tongue of *Scolecomorphus*. *Ichthyophis*, *Hypogeophis*, *Uraeotyphlus*, *Dermophis*, *Herpele* and *Boulengerula*.

(11) The intermaxillary glands of Fahrenholz (zwischenkieferdrüse) are present in *Uraeotyphlus* and absent from *Herpele*, *Boulengerula*, *Dermophis*. *Ichthyophis* and *Hypogeophis*. In *Scolecomorphus*. there is a set of postdental glands and dorsally to this, a set of glands resembling very much the dorsal glands is seen. Since topographically this resembles the intermaxillary of *Uraeotyphlus*, this has also been called intermaxillary gland.

(12) The presence of a Bursa angularis oris in *Scolecomorphus* and a set of oral glands in *Herpele* are recorded.

(13) In *Scolecomorphus* even though the profundus is not separate from the remaining gasserian ganglion, there is no profundus-palatinus anastomosis contrary to the observations of Norris and Hughes.

(14) A palatinus facialis is prominently present in *Boulengerula* contrary to the descriptions of de Villiers.

(15) The dorsal olfactory nerve runs undivided for a long distance in the bony canal of the sphenethmoid in *Boulengerula*.

(16) The ramus mandibularis externus V is absent as an independent nerve in *Scolecomorphus* and *Boulengerula*.

(17) The ramus mandibularis internus VII (chorda tympani) is present in *Scolecomorphus* and *Boulengerula* contrary to the findings of de Villiers.

(18) While Laubmann characterises the tentacle as a " Tastfühler ", Marcus regards it as a " Klopffühler " aiding the animal during burrowing in respiration and olfaction. When the anterior nares close up air is led into the olfactory chamber through the nasolacrimal ducts. This explanation is applicable in all those cases where the tentacle is not situated directly below the anterior nares but behind it as in *Ichthyophis* and *Hypogeophis*. In *Uraeotyphlus* the tentacle is below the naris and during the act of burrowing (if the surface cryptic life can be described so) when the anterior nares close up the tentacle also cannot function and therefore, no air can be led into the " Nebennase ".

Conclusion.—Whether the Apodan skull is primitive and, therefore, bears close resemblance to stegocephalian ancestors or the compactness of the cranium has been acquired secondarily due to a burrowing mode of life is a difficult question to answer. Stadtmüller (1936) mentions in this connection that the ossification of the skull depends upon the use of the head as a borer, but it has already been pointed out that one of the South Indian members, *Ichthyophis*, is not a typical bur-

rower, not digging by the head to lead a subterranean life but lives under rotten vegetation where there is sufficient moisture; this has been called a "surface cryptic" life. According to Cope (1871), Sarasins (1890), Gaupp (1895), Peter (1898), Luther (1914), Jaekel (1927), Goodrich (1930), Werner (1930-31), Versluys (1931), Edgeworth (1935) and de Beer (1937) the stegokrotaphy has been acquired secondarily. In discussing this question we have only to look for clues in the morphology of bones and not in the internal organs since it is impossible to know anything about the soft anatomy of Stegocephalia.

Marcus and his students following Broili, have come to the conclusion that the Apoda are the surviving members of Stegocephalia having come down to the present times in the tropics on account of their cryptic habits. Amongst other features of primitiveness, it is suggested that the possession of a periorbital ring of bones and an interparietal in *Hypogeophis* recalls the stegocephalian relationship. But the occurrence of an interparietal foramen and bone (Hueber 1933) is not accepted by other workers (Stadtmüller).

De Beer (1937, p. 192) in discussing the evolution of Apoda, remarks that "On the other hand, it is noticed that the postfrontal and supratemporal are lacking in Gymnophiona; which they would hardly be if these forms were primitive, since these bones are regularly present in reptiles. The complete roofing in Gymnophiona is therefore probably secondarily developed in connexion with the burrowing habit." It is only the supratemporal that is lacking in Apoda and the postfrontal is noticed in the two genera *Ichthyophis* and *Uraeotyphlus*. Probably the supratemporal has been merged in the adjacent bones and such consolidation is not uncommon amongst Apodan examples.

Boas (1911) found fossae in the Apodan skull and compared them with similar ones in Stegocephalia. According to him, the posterior temporal fossa is lost on account of the fusion of the "temporal roof and paroccipital" part while a pteroccipital gap (seen above and below the stapes when viewed from behind) and lower temporal fossa are present. Thus while the presence of a periorbital ring of bones and fossae point towards stegocephalian ancestry, the absence of a separate supratemporal weights against it.

It is interesting to note that the possession of kinetism throws light on the evolution of these forms. De Beer (1937, p. 427) points out that "the very wide distribution among vertebrates of the basipterygoid process as an articulating facet against which the pterygoid bone can move, points towards the kinetic condition as being the primitive one for the bony skull." Thus the Apodan skull being typically kinetic, is necessarily primitive. Further de Beer (1937, p. 198) infers that "The importance of this case of kinetism is that it is associated with a completely roofed skull, thus showing that there is no intrinsic improbability in the view that the Stegocephalia may have been kinetic." The kinetic possibility has already been observed by workers in Stegocephalia (Stadtmüller, 1936, p. 587). With reference to Apoda, this may mean that the roofed skull possesses kinetic points all of which have been acquired from a stegocephalian ancestor or even though the roofing is secondarily developed due to cryptic habits, yet

the kinetism is retained and therefore the similar stegocephalian skull may also have been kinetic, the latter view put forward by the adherents of the secondary consolidation theory. This naturally leads us to conclude that the kinetism is an ancestral acquisition provided it has not arisen *de novo* in Apoda. Similarly the temporal fossae referred to above.

While the Apoda show these three primitive characters, *viz.*, the possession of periorbital ring of bones, fossae and kinetism, it must also be noted that the cryptic habit is resulting towards greater consolidation of the roofing bones; the formation of a composite nasopremaxilla-maxillopalatine in *Boulengerula* may be cited as an instance. Further, the gradual loss of kinetism is also attributable to it. In *Ichthyophis* and *Uraeotyphlus*, the basipterygoid articulation is lost and is syndesmotic; in *Scolecomorphus* the quadrato-stapedial articulation is lost since the stapes has disappeared. While one kinetic muscle (l. quadrati) is absent in this, the other (M. l. m. posterior) has changed its point of origin. The quadrate in all these is so firmly bound with the squamosal that the movement between the two is considerably lessened thereby heralding a monimostyly. In other words the primitive Apoda are gradually evolving from a kinetic to an akinetic condition.

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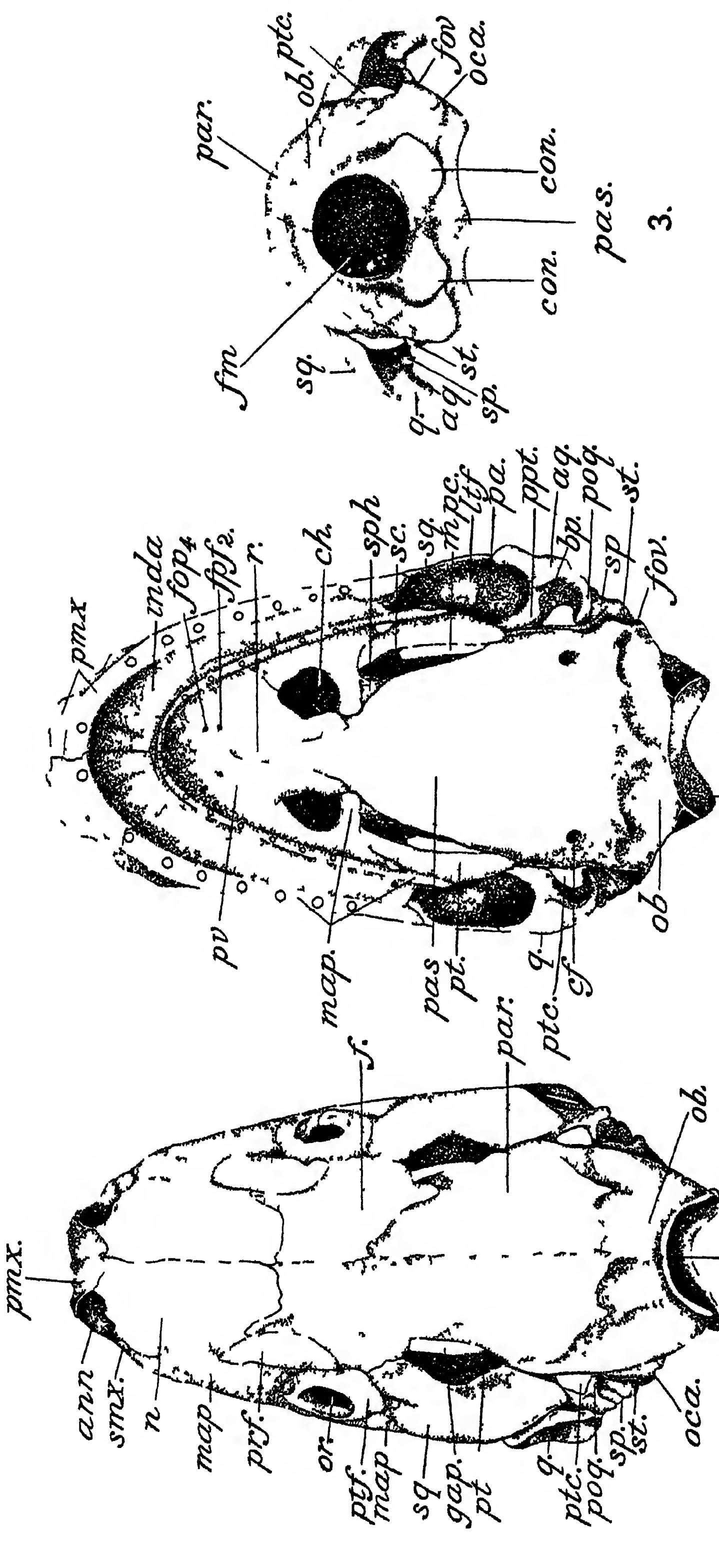
EXPLANATION OF PLATE IV

Skull of *Uraeotyphlus narayani* Seshachar

FIG 1 —Dorsal aspect · × 9
FIG 2 —Ventral aspect × 9
FIG 3 —Posterior aspect × 9.

an anterior nares, *aq* articular facet of the quadrate *bp* basipterygoid process, *ch*, choana *cf* carotid foramen, *con*, condyle, *f* frontal *fm* foramen magnum, *fop*$_4$, foramen for *op*$_4$ branch of ophthalmicus profundus V *for* foramen ovale, *fpf*, foramen for lateral palatinus facialis branch *gap*, fossa between squamosal and parietal *inda*, interdental area *ltf*, lower temporal fossa *map*, maxillopalatine, *mpc*, mediopalatinal cavity *n* nasal, *ob*, os Basale, *oc* otic capsule *or*, orbit, *pa* processus ascendens, *par*, parietal, *pas* parasphenoid portion of os Basale, *pmx*, premaxilla, *poq* processus oticus of quadrate *ppt* processus pterygoideus *prf* prefrontal *pt*, pterygoid *ptc* pteroccipital cavity, *ptf*, postfrontal, *pv* prevomer, *q*, quadrate, *r*, parasphenoidal rostrum of os Basale *sc*, side of cranium, *smx*, septomaxilla *sp*, stapedial process, *sph*, sphenethmoid, *sq*, squamosal, *st*, stapes



Cranial Morphology of *Uraeotyphlus narayani*

EXPLANATION OF PLATE V.

FIG. 1.—Transverse section of *Scolecomorphus uluguruensis* Barbour & Loveridge in the region of eye : × *ca.* 19.

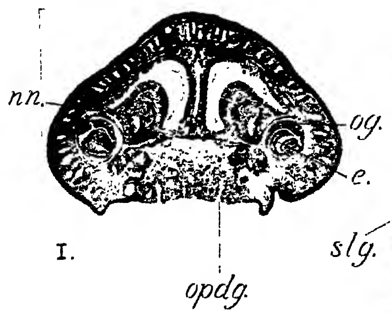
FIG. 2.—Longitudinal section of the tongue of *Ichthyophis glutinosus* (Linn.) : ×44½.

FIG. 3.—Transverse section of the tongue of *Ichthyophis monochrous* (Bleek) : ×*ca.* 14.

FIG. 4.—Transverse section of the head of *Scolecomorphus uluguruensis* Barbour & Loveridge in the eminentia region : ×*ca.* 16.

FIG. 5.—Transverse section of *Uraeotyphlus narayani* Seshachar in the ophthalmicus profundus region : ×*ca.* 53.

aci., arteria carotis interna ; *csb.*, "Choanenschleimbeutel" ; *e.*, eye ; *inmf.*, intermaxillary gland of Fahrenholz ; *lg.*, lingual gland ; *lma.*, M. levator mandibulae anterior ; *lme.*, M. levator mandibulae externus ; *lq.*, M. levator quadrati ; *man.*, r. mandibularis V ; *max.*, r. maxillaris V ; *mgh.*, M. geniohyoideus ; *mgl.*, M. genioglossus ; *mim.*, M. intermandibularis ; *ng.*, nasal gland ; *nn.*, "Nebennase" ; *ob.*, os Basale ; *og.*, orbital gland ; *olg.*, opening of lingual gland ; *op.*, r. ophthalmicus profundus V ; *opdg.*, opening of postdental gland ; *os.*, r. ophthalmicus superficialis VII ; *pdg.*, postdental gland ; *pf.*, r. palatinus facialis ; *pg.*, pharyngeal gland ; *pt.*, pterygoid bone ; *q.*, quadrate ; *se.*, stratified epithelium ; *slg.*, sublingual gland ; *sq.*, squamosal ; *sy.*, syndesmotic connection ; *vcl.*, vena capitis lateralis ; $v_3cpc.$, branch of r. mandibularis V to "Caput preorbitale" and M. compressor orbitalis ; $V_3ls.$, branch of r. mandibularis V to lateral skin ; $V_3me.$, branch of r. mandibularis V to M. levator mandibulae externus.



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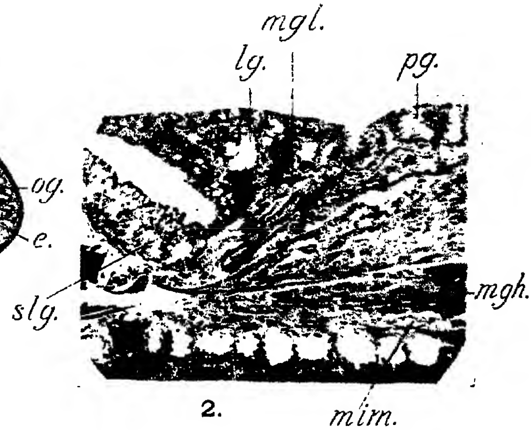

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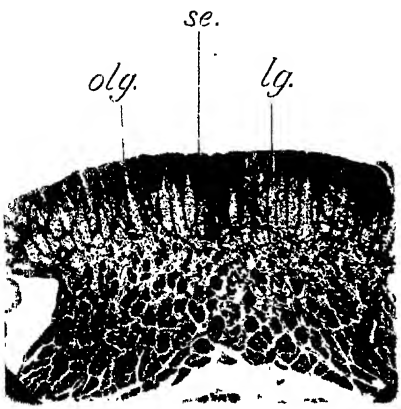

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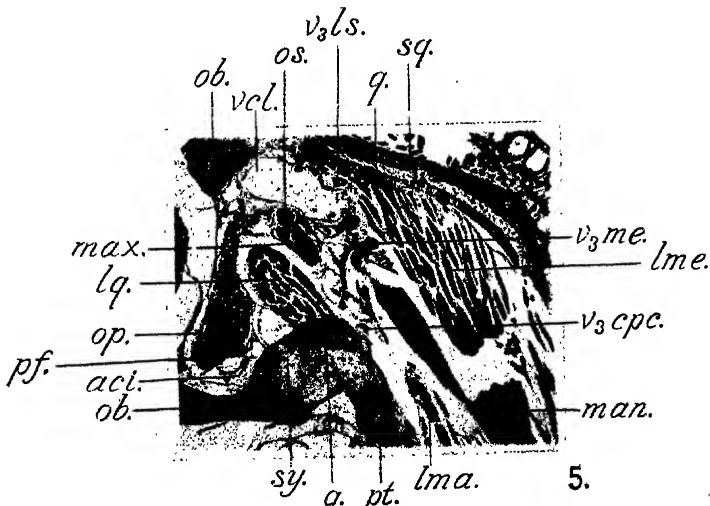


5.

Cranial Morphology of *Uraeotyphlus narayani.*

EXPLANATION OF PLATE VI

FIG. 1.—Transverse section of *Uraeotyphlus narayani* Seshachar in the lingual region. ×15.

FIG. 2.—Transverse section of the lower jaw of *Uraeotyphlus narayani* Seshachar. ×*ca.* 13.

FIG. 3.—Transverse section in the choanal region of *Dermophis gregorii* Boulgr. × 15.

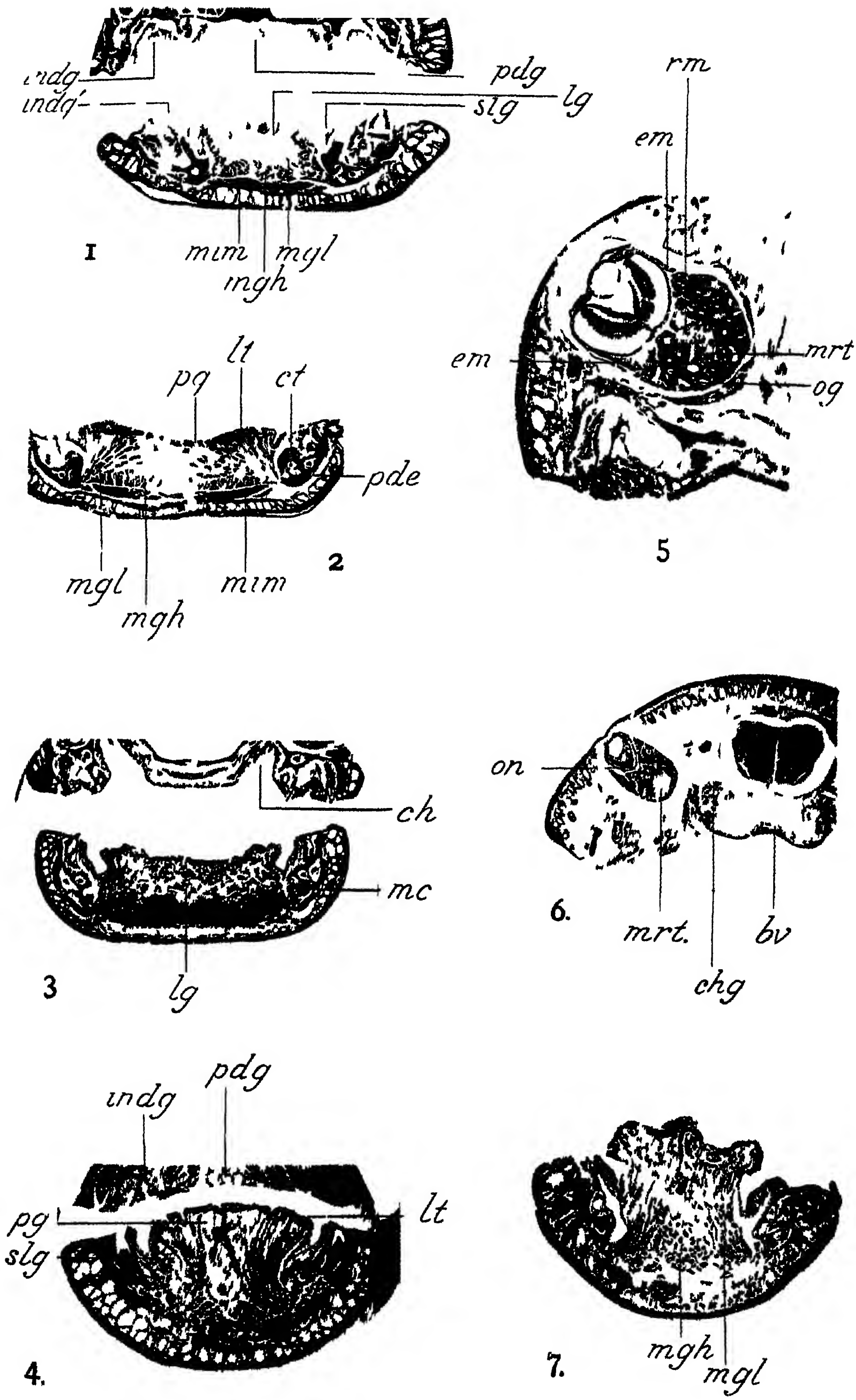
FIG. 4.—Transverse section of the tongue of *Herpele ochrocephala* (Cope). ×*ca.* 14.

FIG. 5.—Transverse section in the region of eye of *Dermophis gregorii* Boulgr. ×36.

FIG. 6.—Transverse section in the region of eye of *Uraeotyphlus narayani* Seshachar. ×15.

FIG. 7.—Transverse section in the region of tongue of *Boulengerula boulengeri* Tornier. ×24.

bv, blood vessel; *ch*, choana; *chg*, choanal gland; *ct*, united rami mandibularis internus V and VII; *em*, eye muscle; *indg*, interdental glands of the upper jaw; *indg'*, interdental glands of the lower jaw; *lg*, lingual gland; *lt*, lateral portion of the tongue; *mc*, Meckel's cartilage; *mgh*, M. geniohyoideus; *mgl*, M. genioglossus; *mim*, M. intermandibularis; *mrt*, M. retractor tentaculi; *og*, orbital gland; *on*, optic nerve; *pde*, pseudodentary; *pdg*, postdental gland; *pg*, pharyngeal gland; *rm*, M. rectus medialis; *slg*, sublingual gland.



Cranial Morphology of *Uraeotyphlus narayani*

A NEW GENUS OF SCHIZOTHORACINE FISHES FROM TRAVANCORE, SOUTH INDIA.

By B. SUNDARA RAJ, *Diwan Bahadur, M.A., Ph.D.* (Liverpool).

(Plate VII)

In this paper a new genus of the Schizothoracine fishes is described from the Periyar Lake, which is an immense irrigation reservoir formed by the damming of the Periyar River, the largest and most important of the rivers of Travancore. It lies at an elevation of 2,709 feet above mean sea level. The Periyar rises in the Shivagiri Forest, on the Cardamom Hills, which form the north-eastern slope of the Western Ghats in Travancore, approximately in Lat. 9° 10′ N. and Long. 77° 17′ E. After a course of 10 miles in a northerly direction to Lat. 9° 31′ N. the river turns due west and flows over a sandy bed for a few miles to Peermade (Pirmed). It then resumes a northerly direction gradually trending westwards, and eventually crossing the Ghats reaches the sea near Cochin. The Periyar Dam is situated in its short east to west reach about 8 miles east of Peermade. The Lake at full supply level has a water spread of 232·80 square miles and a maximum depth of 176 feet. The discharge at the Dam is stated to be equal to half the average flow of Niagara. The Lake is surrounded by an impenetrable, evergreen tropical forest. The average rainfall in Peermade is 198·4 inches annually; it is the highest in all Travancore.

This is the first record[1] of a species of Schizothoracinae from the Tropics. The absence of this subfamily south of the Himalayas and the striking differences between the new genus and all the other known genera of Schizothoracinae might lead one to suspect that the South Indian fish is probably not a member of that subfamily. But the sheath of enlarged scales covering the vent and the base of the anal fin, which is the characteristic feature of that subfamily, and the serrated dorsal spine, the short anal fin and the general form of the fish prove that it is a true Schizothoracine species. The opinion of two leading ichthyologists, Professors L. F. de Beaufort and L. S. Berg, who were consulted, is quite definite. The latter, who is a specialist in the group and who examined a specimen, states:

"The Cyprinoid, as you correctly state, belongs undoubtedly to the Schizothoracinae as is demonstrated by the presence of a scaly sheath at the base of the anal fin and at the anal opening, by its serrated dorsal spine and short anal fin: but it differs from all the known Schizothoracinae in its peculiar scaling and from a lateral line forming a curve on the peduncle. The intestine is rather short and the peritoneum brown (not black). As far as I can judge this genus has affinity neither with *Cyprinon* nor with *Scaphiodon*, both those genera having no scaly sheath at the anal base. It is remotely allied to *Schizopygopsis*."

[1] Dr. Hora has called my attention to a record in 1935 of an unidentified specimen of *Ptychobarbus* from Hyderabad State (Deccan) in the *Journ. Osmania University* III, p. 37. The occurrence of *Ptychobarbus* in plains is so improbable that the identification is open to serious doubt. Several enquiries made have not succeeded in either tracing the specimen or verifying the identification up to the time going to press.

Lepidopygopsis, gen. nov.

The new genus *Lepidopygopsis* is created to receive the South Indian form which differs from the rest of the Schizothoracinae in having a decurved lateral line on the caudal peduncle and in the arrangement and character of its scales and their number along the lateral line. It bears some resemblance to the genus *Schizopygopsis* Steindachner, from which it is readily distinguished by the presence of scales on the caudal portion of the body, a coarsely denticulated dorsal spine, four barbels and triserial pharyngeal teeth.

Genotype.—Lepidopygopsis typus, gen. *et* sp. nov

Lepidopygopsis typus, gen. *et* sp. nov.

(Plate VII, figs. 1-4.)

Local name: "Brahmana Kendai" (Tamil)

B. iii; D. 4/7; A. 3/5; V. 2/8; P. 1/14 (1/13)[1]; C. 19; L. l. 54-58 (54-60)+2; gill rakers 12 (10-12); Vert. 38.

The body is elongate and compressed. Its greatest depth, which is below the commencement of the dorsal fin, is contained 4·25 (4·1-4·65) times in the standard length. The dorsal profile ascends obliquely from the snout to the base of the dorsal fin almost in a straight line, whence it descends more gently also in a straight line to the base of the caudal fin. The ventral profile is curved up to the base of the anal fin but runs more or less straight along the caudal peduncle. The caudal peduncle is more than twice as long as broad at its narrowest part. The head is conical, moderately large and somewhat compressed; its length is contained 9·4 (4·4-4·9) times in the standard length; its width 1·7 (1·8-2) times and its height 1·4 times in its own length.

The eyes, which are moderately large, round and almost lateral in position, are situated more or less in the anterior half of the head. The diameter of the eye is contained 4·4 (2·8-4·4) times in the length of the head. The eyes are proportionately large in the young. The interorbital space is curved and is 1·8 (1-1·8) times the diameter of the eye.

The anterior and posterior nasal apertures are close together and are situated dorsally on either side of the snout midway between the tip of the snout and the anterior margin of the eye.

The snout, which is 1·25 (1·2-1·25) times as broad as long, is swollen, bluntly rounded, and overhangs the mouth. Its anterior border is sharp and entire and forms a deep rostral fold with small lateral lobes (Pl. VII, fig. 3). The large preorbitals extend on either side of the snout and end anteriorly in rounded, vertical borders concealing the lateral lobes of the snout. In one of the paratypes there are pearl organs on the snout. Two small rostral and two maxillary barbels are present; these are subequal, each measuring hardly 1·25 (1·12-1·25) of the diameter of the eye. The rostral barbels arise from the lateral lobes of the snout and the maxillary barbels are at the corners of the mouth.

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[1] In the description the scale counts and measurements of the holotype, which is the largest complete specimen collected, are given; these are followed within brackets by the range of variation, if any, shown by the paratypes.

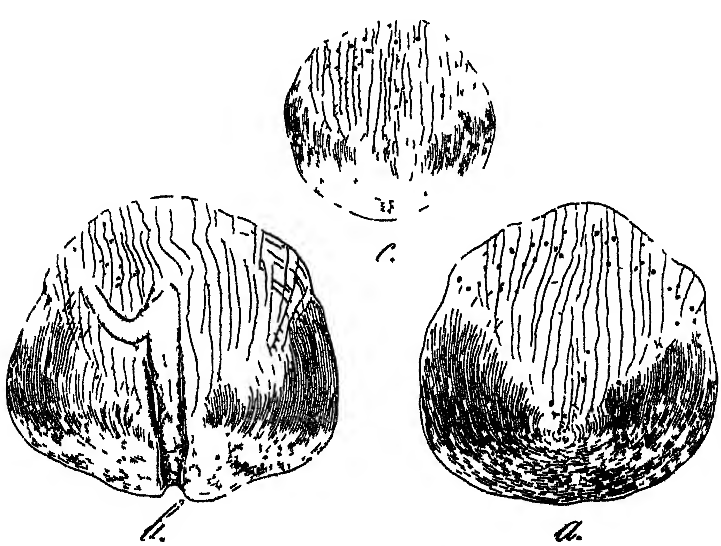
The mouth is inferior, moderately broad and transverse, but curved at the angles. Its cleft is shallow and nearly horizontal. The jaws are feebly protractile. The concealed maxillary does not reach below the anterior border of the eye (it does so in the young). The upper lip, which is thin and loosely invests the upper jaw, is continuous with the lower lip, which is developed only laterally at the curved corners of the mouth. The postlabial groove is broadly interrupted medially. The lower jaw is covered internally by the thin deciduous horny covering with a sharp anterior edge.

The gill opening is wide. It starts dorsally on a level with the upper border of the eye and extends forward ventrally to below the posterior margin of the preopercle. The gill membranes are confluent with the skin of the isthmus. The 10 to 12 short and pointed gill rakers are often curved and are hardly ⅕ as long as the gill filaments which measure half the diameter of the eye. The pseudobranchae are well developed and are provided with filaments.

The pharyngeal teeth (Pl. VII, fig. 4) are pointed and hooked and are in three rows 4-5.3.2—2.3.4-5. The anterior edentulous process of the pharyngeal is about ⅔ as long as the posterior, and the pitted surface is moderately broad.

The alimentary canal is short, about 2·3 times as long as the standard length of the fish. The stomach contents in the specimen dissected consisted of insects, crustacea, diatoms and vegetable matter. The air bladder is of the usual Cyprinoid type and occupies almost the whole length of the body cavity. The peritoneum is brown in colour.

The scales are thin, cycloid, imbricate, and firmly adherent; their greatest diameter being that of the eye. There are no scales on the head, and only a few on the anterior part of the body consisting of a



Scales of *Lepidopygopsis typus*, gen. *et* sp. nov.

a. From scapular region: ×10½; *b.* From lateral line: ×10½; *c.* From caudal peduncle: ×10½.

patch on the scapular region extending as far as the 6th scale on the lateral line, a few scattered scales on the base of the dorsal spine, a continuous row of enlarged scales along the lateral line and another along the midventral line starting from the base of the ventral fins. This latter at the end of the ventral fins constitutes a row of elongated tile-like scales forming a sheath to the vent and the base of the anal fin. The caudal portion of the body behind the dorsal and ventral fins is completely covered by an even, longitudinal series of scales. There are 26 rows of scales round the caudal peduncle and 54-58 on the lateral line, with two more on the base of the caudal fin. The scales are oval, broader than long in the scapular region, more or less rounded on the caudal peduncle and elongate in the anal sheath. A typical scale from the scapular region is oval and has a broad gently convex base, rounded sides with obsolescent basilateral angles and an obtusely pointed apex. The focus is basal in position. Numerous fine circuli cover the whole scale. They are circular and are packed closely at the base, and more distinctly spaced and somewhat indistinct on the apical field. Unlike other Schizothoracinae only apical radii, about 28 in number, are present. They are fine, weak, and more or less parallel lines running up and causing the apical margin to be crenulate. Only a few radii reach the nucleus.

The lateral line is complete and decurved. It runs concurrently with the ventral profile as far as the middle of the caudal peduncle and thence in a straight line along the midlateral line of the body to the base of the caudal fin. The curvature of the lateral line on the caudal peduncle is a feature peculiar to this genus.

The dorsal fin is short and is situated opposite the ventral fin. The length of its base equals the length of the head without the snout. Its origin is closer to the tip of the snout than to the base of the caudal fin. Its free margin is concave. The last undivided dorsal ray, which is almost as high as the body, is osseous, stout, and strongly denticulated along the two sides of its posterior margin. When depressed the first branched ray, which is the longest, reaches well beyond the tips of the last ray and almost half way to the base of the caudal fin. The anal fin is also short; its base is only 0·75 as long as that of the dorsal fin, and has an obtusely straight free margin. It is inserted about midway between the bases of the ventral and caudal fins. The anal fin is shorter in young specimens. The pectoral fin is roughly falciform, nearly as long as the head (shorter in the young), and when depressed reaches three-quarters of the way to the base of the ventral fin which originates about midway between the bases of the pectoral and anal fins. The ventral fin has a slightly concave free margin and is shorter than the pectoral fin. When depressed it reaches about three-fourths of the way to the anal fin. The caudal fin is as long as the distance between the bases of the ventral and anal fins, and is deeply forked with subequal pointed lobes.

The anus is situated on a short papilla.

In fresh specimens the back is olive brown and the sides and ventral surface of the head and body silvery, the dorsal, the caudal, and the distal half of the anal fin olive green. The terminal half of the dorsal

fin has a broad, indistinct dusky band. The caudal lobes and the anterior margin of the anal fin are dusky. The pectoral and ventral fins are hyaline. The iris is silvery.

Relationships.—The exact position of the new genus among the known genera of the subfamily Schizothoracinae is somewhat obscure. It differs from the rest of the subfamily and approaches the Cyprininae more closely than any other genus of the Schizothoracinae in the absence of the basal radii on the scales, and in having fewer scales along the lateral line, which is decurved on the caudal peduncle. While in the character and number of rows of its pharyngeal teeth and in having the caudal portion of its body completely covered by imbricate scales it shows primitive characters; in the loss of scales on the anterior portion of its body it is specialised. Thus it seems to occupy an intermediate position between the primitive genera *Parutylognathus* and *Schizothorax* and the specialised genera *Schizopygopsis*, *Gymnocypris*, etc.

The new genus and species are described from 13 specimens collected in 1936 and half a dozen collected in 1939 from the Periyar Lake. The largest specimen measuring 170 millimetres in standard length has been selected as the holotype.

Holotype.—F13510/1. Zoological Survey of India (*Indian Museum*), Calcutta, from the Periyar Lake, Travancore.

Measurements in millimetres.

	Holotype.	Smallest paratype.
Standard length	170	75
Depth of body	40	18
Length of head	35	17
Width of head	21	8
Height of head	25	11
Diameter of eye	8	6
Interorbital space	15	6
Length of snout	12	5
Width of snout	15	6
Length of caudal peduncle	37	16
Least height of caudal peduncle	16	7
Length of dorsal fin	43	19
Length of pectoral fin	34	15
Length of ventral fin	30	14
Length of anal fin	36	13

Zoogeographical Remarks.—The occurrence so far south in tropical India of a solitary Schizothoracine genus related to *Schizopygopsis* of the Indus and Oxus Rivers to the north-west of India extends the known distribution of the Schizothoracinae very considerably. In the present state of our knowledge of Indian freshwater fish it is also one of the very remarkable instances of discontinuous distribution. A possible explanation for the presence of this trans-Himalayan fish on South Indian Hills is not however far to seek.

According to Jordan[1], while trout and white-fish in Canada and New England travel freely from one river basin to another by descending to

[1] Jordan, D. S., *Fishes*, p. 121 (London: 1925).

the lower reaches or the sea, such a passage of a mountain fish under existing climatic conditions is quite impossible further south, for instance, from the Potomac to the James, in Virginia. The conditions in the north, however, show that such a transfer is possible and will occur, provided climatic conditions favour it at any time. It is generally presumed that the glacial age at the close of the tertiary era in the Northern Hemisphere explains the occurrence of isolated Arctic types in the Lakes of Canada, Sweden, Finland, and in the Gulf of Bothnia, though a direct water communication is postulated. Whether peninsular India was subject to Pleistocene glaciation is doubtful, but geologists consider that sufficient evidence exists in the hilltop flora and fauna of the glacial cold of the north being felt on the plains of India[1].

W. T. Blanford, Medlicott and Oldham[2] state :

"On several isolated Hill ranges such as Nilgiris, Anamalai, Shevaroys and other isolated plateaux in Southern India, and on the mountains of Ceylon, there is found a temperate fauna and flora, which does not exist in the low plains of Southern India, but is closely allied to the temperate fauna and flora of the Himalayas, the Assam range (Garo, Khasi and Naga Hills), the Mountains of Malay Peninsula and of Java.......

"The animals inhabiting the Peninsular and Singalese hills belong, for the most part, to species distinct from those found in the Himalaya and Assam ranges. In some cases even genera are peculiar to the hills of Ceylon, and South India...... There are, however, numerous plants and a few animals inhabiting the hills of Southern India and Ceylon, which are identical with Himalayan and Assamese hill forms, but which are unknown throughout the plains of India."

After discussing various agencies which might have effected such a distribution, the authors conclude, "The only remaining theory, to account for the existence of the same species of animals and plants on the Himalayas and the hills of Southern India, is depression of temperature."

The occurrence, therefore, of this Himalayan and trans-Himalayan subfamily of fish in the Travancore Hills is in line with that of other northern types, such as the Nilgiri wild goat, and is explained by the glacial cold which rendered such a dispersal possible.

I wish to express here my great indebtedness to Dr. Baini Prashad and Dr. S. L. Hora of the Zoological Survey of India for their help in connection with this work. The illustrations were prepared under the supervision of Dr. Hora by Babu B. N. Bagchi.

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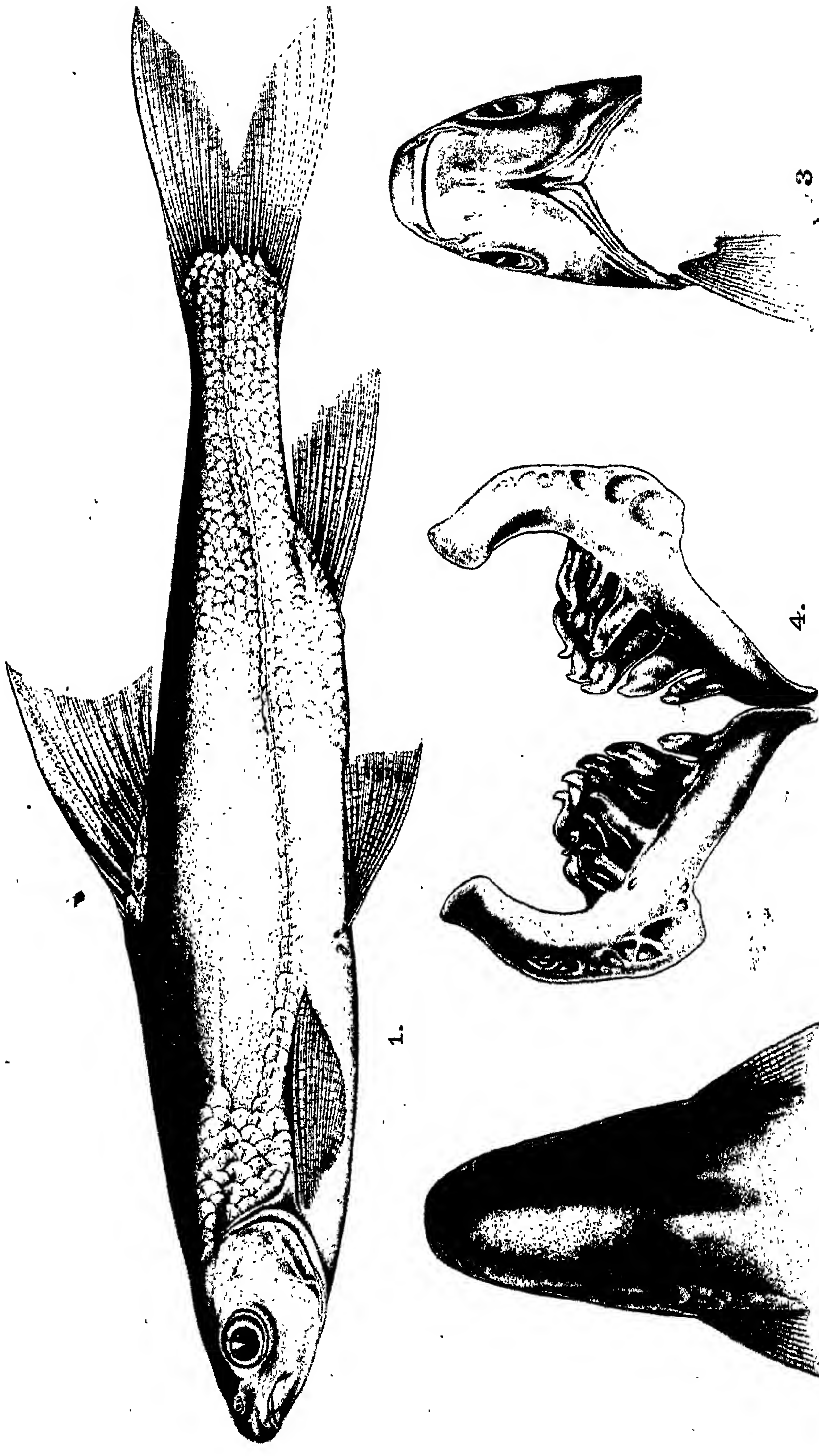
[1] Wadia, D. N., *Geology of India*, pp. 242-246 (London : 1919).

[2] Medlicott, M. A. and Blanford, W. T., *A Manual of the Geology of India*, 2nd ed. (Revised by R. D. Oldham), pp. 13-16 (Calcutta : 1893).

EXPLANATION OF PLATE VII.

Lepidopygopsis typus, gen. *et* sp. nov.

FIG. 1.—Lateral view of the holotype: $\times\frac{7}{8}$.
FIG. 2.—Dorsal view of head: $\times 1\frac{5}{16}$.
FIG. 3.—Ventral view of head: $\times 1\frac{5}{16}$.
FIG. 4.—Pharyngeal bones and teeth of a paratype: $\times 9\frac{5}{8}$.



Lepidopygopsis typus, gen. *et* sp. nov.

B. N. Bagchi, del.

ON THE NATURAL HISTORY OF *KOWALA THORACATA* CUV. & VAL., WITH SPECIAL REFERENCE TO ITS GONADS AND EGGS.[1]

By D. W. DEVANESAN, *M.A.*, *D.I.C.*, *Ph.D.* (*London*), and V. JOHN, *B.A.*, *Fisheries Section*, *Department of Industries and Commerce*, *Madras*.

The beautiful sardine *Kowala thoracata* Cuv. & Val. yields an important seasonal fishery on the west coast of India, and has consequently been one of the subjects of study in the Marine Biological Station, West Hill, Calicut, since 1930. The species was first described by Cuvier and Valenciennes[2] under two names *Kowala thoracata* and *Meletta lile*, but Regan[3] has shown that the two names refer to the same species for which he selected the name *Kowala thoracata* presumably on the basis of its page priority. Regan gives the range of distribution of this fish as "Kurrachee to New Guinea", while according to Fowler[4] *Clupeoides lile* is found from "Western India to East Indies and Tahiti".

The fishery of this sardine commences on the West Coast in July and lasts till March. According to the statistics collected by the Department of Fisheries, Madras, on an average about 10,000 maunds valued at Rs. 17,000 are caught annually from the Malabar and South Kanara coasts. It is mostly consumed fresh, but the surplus in the case of heavy catches is salted and dried.

Food.—*Kowala thoracata* feeds on plankton. The following organisms have been found in its stomach-contents:

I.—*Zooplankton.*—(1) Copepods consisting chiefly of *Paracalanus* sp., *Acartia* sp., *Oithona* sp., (2) *Evadne* sp., (3) Crab-Zoea, (4) Larval bivalves, and (5) Fish-eggs.

II. *Phytoplankton.*— (1) Species of *Coscinodiscus*, such as *C. jonesianus*, *C. gigas* var. *diorama*, and *C. oculus-iridis*, (2) *Fragilaria* sp., (3) *Chaetoceras lorenzianum*, (4) *Thallasiothrix nitzschioides*, (5) *Ceratium massiliense*, (6) *Peridinium depressum* and *P. ovatum*, (7) *Tintinnus* sp., (8) *Dinophysis homunculus*, and (9) *Biddulphia sp.*

Kowala thoracata appears to be destructive to fish-eggs and in one instance its food was found to consist mainly of eggs of the South Indian mackerel, *Scombrus microlepidotus*. It is very likely that it follows spawning shoals of fish and feeds on their eggs. This may be responsible for the natural fluctuations in the abundance of the fishes on whose eggs it feeds.

Size, Maturity and Spawning Season.—Specimens ranging from 60 mm. to 120 mm. in length have been collected. Day[5] mentions that the species attains "about 4 inches in length". Young specimens less than 60 mm. have not been found in the commercial catches.

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[1] Published with permission of the Director of Industries, Madras.

[2] Cuvier, G. and Valenciennes, A., *Hist. Nat. Poiss.* XX, p. 363, 378 (1847).

[3] Regan, C. T. *Ann. Mag. Nat. Hist.* (9) X, p. 588 (1922).

[4] Fowler, H. W., The Fishes of Oceania, *Mem. Bernice P. Bishop Mus.* X, p. 31 (1928).

[5] Day, F., *Fishes of India*, pp. 638, 639, pl, clxii, fig. 1 (1878).

Fish measuring 100-110 mm. formed the bulk of the specimens sampled and examined. Sexual maturity is attained when the fish reach a length of about 90 mm.

Specimens partly or fully spent were seen in February 1936. In December 1938, female specimens with fully mature transparent ova were obtained. It may, therefore, be inferred that spawning season of this sardine roughly ranges between the months of November and February.

Reproductive organs and eggs.—The left ovary and the left testis only are functional. The right ovary and the right testis are vestigial, as sections showed neither oogonia nor spermatogonia respectively. One would expect this character to be included among the generic characters of the genus *Kowala*, but the fact that it has not been done indicates that this has not been noticed previously. A sinistrorse emphasis in the organisation of animals is found in other groups as well, as for instance, in the survival and development of the organs on the left side of the Echinoderm larvae, the functioning of the left ovary and oviduct in Aves, and the functioning of the left ovary in Monotremes. In the last two cases the males are not affected, whereas in *Kowala thoracata* both sexes are affected. This phenomenon of sinistrorse emphasis coupled with the dexteratrophy either in one sex or in both sexes is not easy to explain. What factors were instrumental in the organs of one side in the ancestors of a bilaterally symmetrical animal becoming reduced and those of the other better developed, and why should the left have got the stress and not the right? These are problems for the animal physiologists and embryologists.

On 1st December, 1938, female specimens with mature transparent ova occurred in the catches. Artificial fertilisation resulted in the formation of the vitelline membrane indicating perhaps fertilisation. The fertilised egg is a typical clupeoid egg with vacuolated yolk and a large space between the egg-proper and the vitelline membrane. A number of yellow oil-globules are found in each egg, the number varying from four to eight. The entire egg including the perivitelline space measure about 0·8 mm. in diameter. The number of eggs on an average in a ripe female is about 8,000 which is a comparatively low figure for a clupeid. Even making allowance for the atrophy of the right ovary, the fecundity of this sardine is low when compared with that of the herring (*Clupea harengus*) and the pilchard (*Clupea pilchardus*) which lay about 30,000 and 60,000 eggs respectively.

A NEW GENUS AND SPECIES OF NEMATODES PARASITIC IN A "PIKA" FROM AFGHANISTAN.

By S. A. AKHTAR. *Professor of Biology. Faculty of Medicine. Kabul.*

A specimen of a rodent locally known as "pika" (*Ochotona* sp.) captured from a hill near Surchashma (a village at the source of Kabul river and about 60 miles south west of the city) was on dissection found to be heavily infected with small white nematode worms in its large intestine.

The worms belong to the family Oxyuridae Cobbold, 1864: and the subfamily Oxyurinae Hall, 1916. They exhibit affinities with the genus *Dermatoxys* Schneider, 1866; in having an oesophageal bulb, caudal alae in males and in the form of tail in the females and the shape of the eggs. They also resemble to some extent the genus *Protozoophaga* Travassos, 1923, in having a circumoral membrane supported by cephalic papillae. They. however, differ markedly from both the genera in the mouth being surrounded by six distinct, small, bilobed lips and in the absence of cervical alae, valvular apparatus and the wide oesophageal cavity. There are neither comb-like crests on the ventral surface nor a terminal process in the males. These differences are of sufficient importance for the creation of a new genus *Labiostomum* for these worms, which appears to be intermediate between the genera *Dermatoxys* and *Protozoophaga* referred to above.

Labiostomum, gen. nov.

Mouth hexagonal, surrounded by six bilobed lips. each supported by chitinous bars; cuticle of the head region inflated all round to form a well-defined cephalic bulb. supported by many cephalic papillae; oesophagus long, club-shaped, followed by a bulb. separated from the rest by a constriction, and without a valvular apparatus. *Male*: tail short, ending in a blunt point: caudal alae long and narrow, with a number of papillae close to the anus; spicule short, lightly chitinised; gubernaculum absent. *Female*: tail long. gradually tapering; vulva in front of the middle of the body; oviparous: eggs asymmetrical with rugose shells. and a plug at one pole.

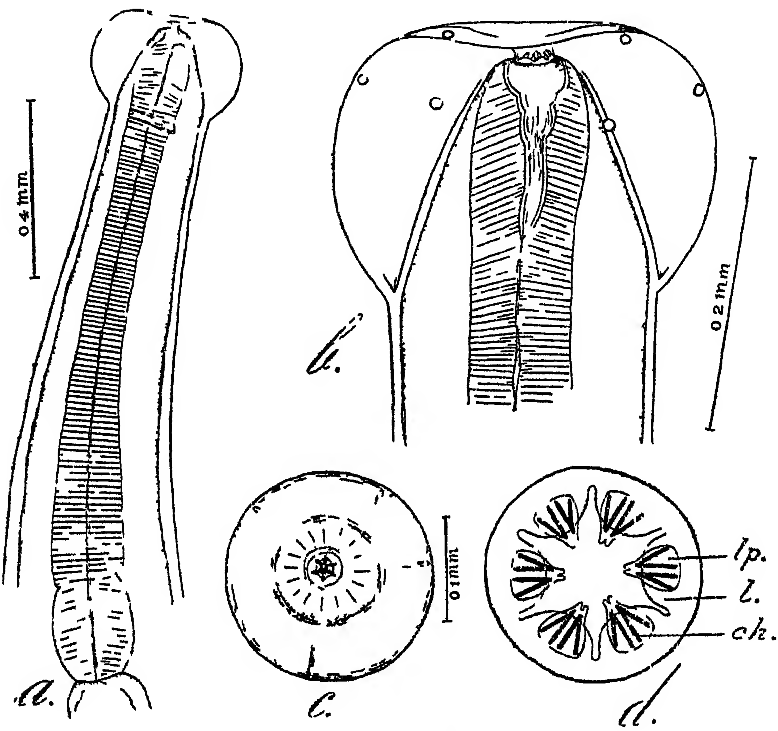
Genotype.—Labiostomum naimi. gen. *et* sp. nov.

Labiostomum naimi[1], gen. *et* sp. nov.

Body is cylindrical. finely striated transversely and with lateral alae. The cuticle of the head region is inflated to form a well-defined cephalic bulb, supported by about six cephalic papillae. Mouth hexagonal, surrounded by six small. conical and bilobed lips, each of which is supported by four chitinous bars. two placed laterally and two medially

[1] The species is named after H. E. Sardar Mohd. Naim Khan, Minister of Education, Afghanistan.

near each other. Buccal cavity present; oesophagus club-shaped with a distinct posterior bulb, separated from the rest by a constriction. The bulb is without a valvular apparatus, and the intestine is simple and straight. The nerve ring is situated a little above the termination of the cephalic bulb or near the beginning of the narrow lateral alae.



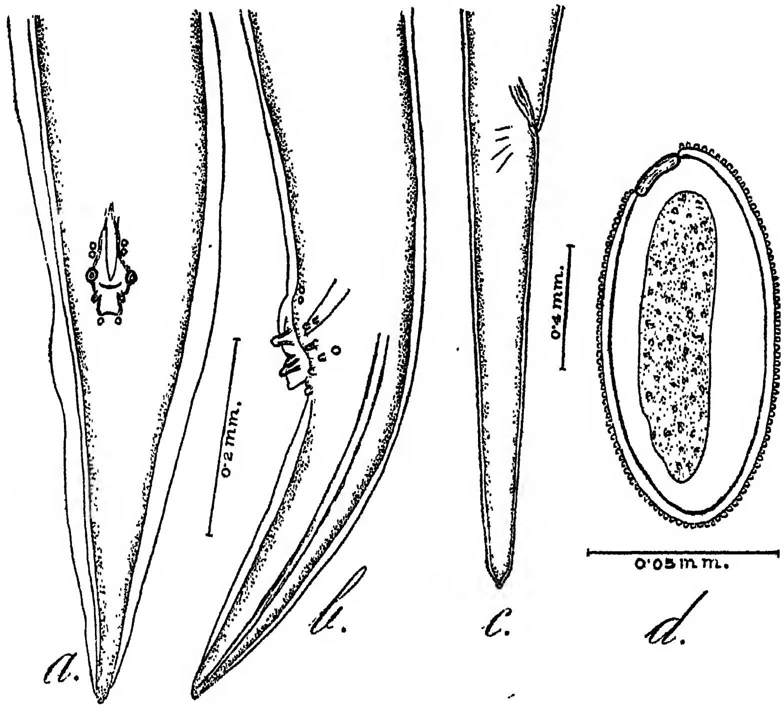
Text-fig. 1.—*Labiostomum naimi*, gen. *et* sp. nov.

a. Anterior extremity of female, lateral view; *b.* Anterior extremity of female, lateral view, more enlarged; *c.* Head, front view; *d.* Mouth, front view, diagrammatic.

ch., chitinous bar; *l*, ledge; *lp.*, lip.

The male is smaller than the female; it is 3·397 mm. long and 0·283 mm. thick. The diameter of the cephalic bulb is 0·245 mm. The length of the vestibule is 0·020 mm. and that of the oesophagus 0·832 mm. The posterior bulb is 0·150 mm. in length and 0·130 mm. in diameter. The length of the tail is 0·436 mm. The tail is short, alate and incurved; it ends in a blunt point. The caudal alae are long and narrow. The spicule is short and lightly chitinised, it is 0·067 mm. long. The gubernaculum is absent. The caudal papillae are grouped in the vicinity of the cloaca where the cuticle is somewhat thicker. There are about eleven pairs of caudal papillae with the following arrangement :—Five pairs pre-anal, three pairs ventral and two pairs lateral; three pairs adanal, situated rather laterally; and three pairs post-anal, one pair

lateral and two pairs ventral. The papillae of the third pre-anal pair and the first post-anal pair are larger than others.



Text-Fig. 2.—*Labiostomum naimi*, gen. *et* sp. nov.

a. Posterior extremity of male, ventral view; *b.* Posterior extremity of male, lateral view; *c.* Posterior extremity of female, lateral view; *d.* Egg.

The female is 14·960 mm. long and 0·445 mm. thick. The cephalic bulb is 0·290 mm. in diameter. Narrow lateral alae extend posteriorly to the level of anus. The vestibule is 0·025 mm., and the oesophagus 1·333 mm. long. The posterior bulb is 0·183 mm. long and 0·143 mm. thick. The vulva is prominent and situated at a distance of 6·867 mm. from the anterior end of the body. The tail is long and ends into a short blunt cone. Its length is 1·240 mm. The eggs are asymmetrical with rugose shells and a plug at one pole, measuring 0·090 x 0·043 mm.

Type-specimen.—No. W 3443/1, Zoological Survey of India (*Ind. Mus.*), Calcutta.

HOMALOPTERID FISHES FROM PENINSULAR INDIA.

By SUNDER LAL HORA, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Assistant Superintendent*, *Zoological Survey of India, Calcutta.*

(Plate VIII.)

In 1920[1], attention was directed to the great confusion that prevailed in the taxonomy of the Indian species of the family Homalopteridae, and three distinct genera were recognised on the basis of the form of the pectoral fins and head, the nature of the lips and barbels, the general shape of the body and the number of rays in the pectoral fins. For the species found in Peninsular India, a new genus *Bhavania* was proposed but unfortunately at that time no attention was paid to the nature of its gill-openings, which in *Bhavania* are restricted above the bases of the pectorals, a feature unique among the Homalopterinae. In my[2] general revision of the Homalopteridae, *Bhavania* was treated as a synonym of *Homaloptera* van Hass., for I had then examined several species of *Homaloptera* in various collections in which the head was broad and rounded like that of *Balitora* and approached the condition found in *Bhavania*. However, in 1937[3], when examining a series of well preserved specimens collected from a stream on the road-side between Kottigehar and Balehonnur, Western Ghats, Mysore State, the gill-opening was found to be very small and restricted above the base of the pectoral fin. The earlier material referred to *Bhavania* was found to be of the same nature. This led me to revive the genus on this very important character.

Recently, Mr. S. Jones, at my request, sent me a small collection of freshwater fishes from Travancore, and in this lot, besides specimens of *Bhavania*, a number of specimens with the gill-openings extending to the ventral surface for a short distance were also found. These examples are remarkable in several respects and for their reception a new genus *Travancoria* is proposed in this paper.

At my request, the Superintendent, Government Museum, Madras, sent me the only specimen of the Homalopteridae in the collection under his charge. The small specimen was collected by Dr. F. H. Gravely at Sivasamudram (alt. 1,500-2,000 ft.). Mysore, in May 1921, and belongs to *Balitora* Gray. In fact, it is closely allied to *B. brucei* Gray, a species of the Assam Hills and the Eastern Himalayas; but the head is more pointed, the body is not so flattened and the number of unbranched rays in the pectoral fins is less. In these respects, it agrees with the Burmese variety[4] of the species, but till more material of this form becomes available for comparison I propose to describe it as a new variety of *B. brucei*.

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[1] Hora, S. L., *Rec. Ind. Mus* XIX, pp. 195-207 (1920).
[2] Hora, S. L., *Mem Ind. Mus.* XII, pp. 274-277 (1932).
[3] Hora, S. L, *Rec Ind. Mus* XXXIX, p. 11 (1937).
[4] Hora, S. L., *Mem. Ind. Mus*, XII, p. 291, pl. xi, fig. 6 (1932).

In view of considerable fresh material having been obtained of *Bhavania* from several parts of Peninsular India, a complete definition of the genus and a revision of its species is also included. In order to define the systematic position of the three South Indian genera, a key to all the known genera of the Homalopterinae is given below.

Key to the genera of the Homalopterinae.

I. Gill-opening small, situated entirely above base of pectoral. (Two anterior rays of pelvic fin simple.) ... *Bhavania*

II. Gill-opening of moderate size, extending to ventral surface for short distance.

- A. Two anterior rays of pelvic fin simple.
  - 1. Rostral groove in front of mouth absent or very poorly developed; rostral fold absent or very slightly developed (Lips simple, continuous and without papillae). .. .. .. *Homaloptera*.
  - 2. Deep rostral groove in front of mouth present, overhung by rostral fold.
    - *a*. Seven or more rostral barbels arranged in two series; lips simple, continuous at angles of mouth; lower lip with a separate median portion followed by two prominent papillae. *Travancoria*.
    - *b*. Four rostral barbels in one row; lips, especially the upper strongly papillated; both lips continuous; lower lip not followed by medially situated papillae.
      - i. Two barbels at each angle of mouth; 7-8 anterior rays of pectoral simple; body subcylindrical with flattened ventral surface; snout pointed. .. .. .. *Sinohomaloptera*
      - ii. One barbel at each angle of mouth; 9-10 anterior rays of pectoral simple; body greatly depressed and flattened; snout rounded and trenchant. .. .. *Balitora*.
- B. Three or more anterior rays of pelvic fin simple.
  - 1. Pelvics free from each other, not united to form a disc-like structure.
    - *a*. Tail long and slender; least height of caudal peduncle less than diameter of eye; lips fimbriated; 3 barbels at each angle of mouth. .. .. *Lepturichthys*.
    - *b*. Tail stout and deep; least height of caudal peduncle greater than diameter of eye; lips papillated; 2 barbels at each angle of mouth. .. .. *Hemimyzon*.
  - 2. Pelvics united posteriorly to form a disc-like structure. .. .. .. *Sinogastromyzon*.

Of the three genera known from Peninsular India, *Bhavania* is more widely distributed along the Western Ghats having been recorded from the Malabar Hills, Wynaad, Nilgiris, Mysore and Travancore. *Travancoria* is so far known only from the Travancore Hills; it has been found in streams within a radius of about 5 miles of Pampadampara, Peerumedu Taluq, Travancore. *Balitora* is known from the Mysore State, besides north-east Bengal, Chittagong Hill Tract, Assam and Burma.

As a group, the Homalopteridae are extensively distributed in the hills of south-eastern Asia, but in India proper they are found in the hills of Assam and Chittagong, in the Eastern Himalayas as far as the

Tista River System, and in the hills of Peninsular India. In 1932, I (*loc. cit.*, p. 288) was unable to explain how the Homalopteridae spread from the Assam Hills to the Western Ghats, but since then I[1] have adduced evidence to show that the torrential fauna of the north-east spread along the Satpura Trend to south-west. The discovery of another new genus of Homalopterid fishes from South India and the extension of the range of *Balitora* to Peninsular India lend additional support to a large-scale migration of the hill-stream fauna along the route stated above.

In describing a remarkable new genus of Schizothoracine fishes from the Periyar Lake, Travancore, Sundara Raj[2] made remarks on the zoo-geographical significance of his discovery. He has followed the views of Medlicott, Blanford and Oldham[3] and their conclusion that " The only remaining theory, to account for the existence of the same species of animals and plants on the Himalayas and the Hills of Southern India, is depression of temperature. " The glacial cold may have helped in the dispersal of the terrestrial fauna from the north to the south, but without direct water communications between the two areas it is difficult to believe that mere depression of temperature could influence the dispersal of aquatic fauna to such distant places as the Himalayas and the hills of Travancore. Moreover, for the dispersal of the torrential Homalopteridae we not only require direct water communication between the Eastern Himalayas (Homalopteridae are not found to the west of the Tista Drainage) and the southern portion of the Western Ghats, but also torrential waters between these two areas, for which one has to postulate a connected chain of hills. This condition is fully satisfied by the Satpura Trend theory advanced by me in recent years and referred to above.

Both *Bhavania* and *Travancoria* are *Balitora*-like in their general facies, nature of paired fins, and the characters associated with the mouth, such as rostral groove, rostral fold, etc. There would thus appear to be a close association of the South Indian forms, and it is probable that these three genera developed along independent lines from a common *Homaloptera*-like ancestral form. The isolation of the Peninsular forms from the main stock of the family for a sufficiently long time seems to have induced in some of them characters which are not found in any other member of the Homalopterinae but are only paralleled among the Gastromyzoninae, which spread more towards east and south from the central highlands of south-eastern Asia.

I wish to express my great indebtedness to Mr. S. Jones, Dr. C. C. John, Prof. A. Subba Rau and Mr. B. S. Bhimachar for their kindness in making collections of freshwater fish for me in Travancore and Mysore. Besides enriching the national collection at the Indian Museum; these have enabled me to describe several new and little known forms from among them. I am also grateful to the Superintendent, Government Museum, Madras, for the presentation of the specimen from

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[1] Hora, S. L., *Proc. Nat. Inst. Sci. India* IV, p. 405 (1938).

[2] Raj, B. Sundara, *Rec. Ind. Mus.* XLIII, pp. 213, 214 (1941).

[3] Medlicott, M. A. and Blanford, W. T., *A Manual of the Geology of India*, 2nd ed. (Revised by R. D. Oldham), pp. 13-16 (Calcutta: 1893).

Sivasamudram to the Indian Museum. My thanks are also due to Mr. K. K. Nair for drawing up the tables of measurements and to Messrs. R. Bagchi and B. N. Bagchi for preparing the illustrations.

Bhavania Hora.

1848. *Platycara*, Jerdon (*nec* McClelland), *Madras Journ. Litt. Sci.* XV, *p.* 333.
1868. *Homaloptera*, Günther (in part), *Cat. Fish. Brit. Mus.* VII, p. 340.
1872. *Homaloptera*, Day (in part), *Journ. As. Soc. Bengal* XLI, p. 28.
1877. *Homaloptera*, Day (in part), *Fish. India*, p. 525.
1889. *Homaloptera*, Day (in part), *Faun. Brit. Ind.* Fish. I, p. 242.
1920. *Bhavania*, Hora, *Rec. Ind. Mus.* XIX, p. 202.
1931. *Homaloptera*, Hora (in part), *Rec. Ind. Mus.* XXXIII, p. 68.
1932. *Homaloptera*, Hora (in part), *Mem. Ind. Mus.* XII, p. 274.
1937. *Bhavania*, Hora, *Rec. Ind. Mus.* XXXIX, p. 11.

The head and the anterior part of the body are greatly depressed while the tail region is compressed from side to side. The ventral surface up to the anal opening is flattened. The snout is broadly pointed and is provided with more or less trenchant margins. The eyes are dorso-lateral, are provided with free orbital margins and are not visible from the ventral surface. The mouth is small. considerably less than half the width of the head, inferior, transverse and lunate. The lips are fleshy and leave the jaw free and partly uncovered; they are continuous at the angles of the mouth but the lower lip is divided into one central and two lateral portions: the middle part is followed by two prominent papillae. In front of the mouth, there is a narrow groove overhung by the rostral fold, from the front margin of which, forming indentations, arise four rostral barbels. Two lappets of the rostral fold curve inwards between the rostral and the maxillary barbels. The rostral groove is continuous with the grooves at the angles of the mouth. The jaws are sharp and covered with a horny substance. The gill-openings are small and restricted to the dorsal surface considerably above the bases of the pectoral fins. The body is covered with small scales which are absent on the ventral surface in front of the anal opening. The scales are provided with short. pointed keels which are continued on the head as series of tubercles. The dorsal and the anal fins are short; the former commences slightly behind the pelvics. The paired fins are horizontal and extensive; the pectoral commences slightly behind the eye and extends to the base of the pelvic which extends beyond the anal opening. Between the bases of the pectoral and ventral fins, the body extends outwards and is broadest in front of the bases of the ventrals. The pectoral is provided with 19 rays, of which 6-8 anterior rays are simple. The ventral is provided with 9 rays of which two are simple. The caudal fin is slightly emarginate and some of the outer rays are fused to form oar-like solid structures.

Genotype.—Platycara australis Jerdon (=*Bhavania annandalei* Hora).

Relationships.—Among the Homalopterinae, *Bhavania* is the only genus in which the gill-openings are restircted to the dorsal surface of the head and in this respect its development seems to be parallel to several genera of the Gastromyzoninae, such as *Protomyzon*, *Paraprotomyzon*, *Pseudogastromyzon*, *Sewellia*, *Beaufortia*, *Neogastromyzon* and *Gastromyzon*.

Bhavania australis (Jerdon).

Plate VIII, figs. 1-3.

1848. *Platycara Australis*, Jerdon, *Madras Journ. Litt. Sci.* XV, p. 333 (Walliar).
1867. *Homaloptera brucei*, Day (*nec* Gray), *Proc. Zool. Soc. London*, p. 348 (Wynaad).
1868. *Homaloptera brucei*, Günther (*nec* Gray), *Cat. Fish, Brit. Mus.* V, p. 340 (Wynaad: Mr. Day's Collection).
1872. *Homaloptera brucei*, Day (*nec* Gray), *Journ. As. Soc. Bengal* XLI, p. 28 (Wynaad).
1877. *Homaloptera maculata*, Day (*nec* Gray), *Fish. India*, p. 526, pl. cxxii, fig. 2 (Wynaad specimen figured).
1889. *Homaloptera maculata*, Day (*nec* Gray), *Faun. Brit. Ind.* Fish. 1, p. 243 (Wynaad, Nilgiris).
1909. *Homaloptera maculata*, Jenkins (*nec* Gray), *Rec. Ind. Mus.* III, p. 289 (Tenmalai, Western Ghats).
1920. *Bhavania annandalei*, Hora, *Rec. Ind. Mus.* XIX, p. 203, pl. x, figs. 1-3; pl. xi, figs. 5-7 (Travancore, Nilgiris and Malabar).
1920. *Bhavania australis*, Hora, *ibid.*, p. 205. pl. x, figs. 4-6, pl. xi, fig. 8.
1929. *Homaloptera maculata*, Pillay (*nec* Gray), *Journ. Bombay Nat. Hist. Soc.* XXXIII, p. 356.
1936. *Homaloptera maculata*, John (*nec* Gray), *ibid.*, XXXVIII, p. 710.
1937. *Bhavania annandalei*, Hora, *ibid.*, XXXIX, p. 11, text-fig. 4 (Western Ghats, Mysore State).

In 1867, Day recorded *Homaloptera brucei* from the Wynaad hills and assigned *Platycara australis* Jerdon to its synonymy. One of Day's specimens from the Wynaad later served for Günther's description of *H. brucei*[1]. However, in 1877, when Day[2] had obtained specimens of the real *Balitora brucei* Gray from the Darjeeling Himalayas and the hills of Assam, he regarded the Wynaad examples as *H. maculata*, but at the same time included all his earlier references, based on the Wynaad specimens, to *H. brucei* in the synonymy of the real *H. brucei*. Thus a great confusion was created by him in the systematic position and the geographical distribution of the Homalopterid fishes known from the Eastern Himalayas and Peninsular India respectively.

Vinciguerra[3] found considerable difficulty in determining his Burmese examples of *H. brucei*, for he found great discrepancies in Day's earlier and later descriptions of the species and pointed out that the specimens found in the Nilgiri Hills must be regarded as specifically different from the specimens described by Day in the *Fishes of India* as *H. brucei*. In 1920, it was shown by me[4] that Vinciguerra was correct in his analysis of Day's descriptions and a new genus *Bhavania* was proposed for the South Indian forms. Relying mainly on immature specimens, I recognised two species in this genus, but examination of further material has convinced me that the two species are identical, and the earlier name *australis* must, therefore, be used for them.

Unfortunately Jerdon's description of *Platycara australis* is rather vague and applicable to more than one species. He stated: —

"Muzzle depressed, snout somewhat pointed; eyes approximated; body greenish with irregular spots and blotches of brown and red, and a series of white spots along the sides; fins greenish, tinged with sienna red and spotted; caudal with the lobes pointed lower one much the longest; 4 minute cirri at end of snout, and 2 somewhat fleshy short cirri, one in front of and the other behind the mouth. Length about 2½ inches—D.7, A. 6."

[1] Günther's *Homaloptera maculata* from Assam is in reality *Balitora brucei* Gray.
[2] Day, F., *Fish India*, p. 526, pl. cxxii, fig. 1 (1877).
[3] Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* XXIX, pp. 320-335 (1890).
[4] Hora, S. L., *Rec. Ind. Mus.* XIX, pp. 195-207 (1920).

The nature of the barbels is the only character in the above description which enables this species to be distinguished from the new species described below, for the colouration is more or less similar in the two forms.

In view of considerable fresh material having been obtained from different parts of Peninsular India, the species may now be redescribed as follows :—

D. 2/7-9 ; A. 1/5-6 : P. 6-8/9-11 ; V. 2/7-8 : C. 17-18.

Bhavania australis is a *Balitora*-like fish in which the head and the anterior part of the body up to the anal opening are greatly depressed and the ventral surface is flat and horizontal. The tail is broad and compressed from side to side. The dorsal profile is gently arched, the greatest height of the body being in front of the dorsal fin. The head is broad, rounded and almost trenchant : it is covered with series of short, hard, spine-like growths. The length of the head is contained from 4·37 to 5·42 times in the standard length and from 5·15 to 6·46 times in the total length ; the head is proportionately larger in smaller individuals. The head is almost as broad as long ; its breadth is contained from 1·05 to 1·28 times in its length. The eyes are of moderate size, approximated dorsally and situated in the posterior half of the head : they are not visible from the ventral surface. The diameter of the eye is contained from 3·88 to 5·59 times in the length of the head, from 1·94 to 3·19 times in the length of the snout and from 1·38 to 2·00 times in the interorbital width ; the eyes are proportionately larger in smaller individuals. The nostrils are situated close to the anterior border of the eye ; the anterior nostril is situated in a flap which covers the posterior nostril. The mouth is small, inferior, semicircular and horizontal ; the gape of the mouth is about one-fifth of the width of the head. The lips are well developed and free from the jaws and leave a considerable portion of the jaws uncovered. Both the lips are continuous at the angles of the mouth but the median part of the posterior lip is separated off from the lateral parts and is followed by two prominent barbel-like papillae. The jaws are hard and covered by a horny substance ; the posterior jaw is rounded and shovel-like. Between the anterior lip and the rostral fold, there is a deep groove which is bifurcated near the origin of the maxillary barbel ; the inner branch is continued round the angles of the mouth while the outer branch is continued outwards and backwards. There are 6 short, stumpy barbels, 4 rostral and 2 maxillary. In between the rostral barbels, the rostral fold is produced into lobes and at the sides lappets are formed which cover parts of the rostral groove. The gill-openings are small, spout-like apertures which are restricted above the base of the pectoral fin. The gill-membranes are broad and thick.

The depth of the body is contained from 6·45 to 9·34 times in the standard length and from 8 to 11 times in the total length ; the body is proportionately more elevated in larger specimens. Between the bases of the pectoral and pelvic fins the body becomes broader posteriorly and is almost as wide as the width of the head. The caudal peduncle is well formed ; its least height is contained from 1·55 to 2·28 times in its length. The body is covered with small scales which are absent

Measurements in millimetres.

—	Kottigehar, Mysore.	Sethumadai Hills, Mysore.				Kallar Stream, South Travancore.				Pampadampara, North Travancore.	
Standard length	27·1	38·1	46·2	71·0	71·6	67·4	71·8	74·2	77·9	54·9	84·2
Length of caudal	4·8	8·1	D.	D.	D.	14·9	16·2	16·2	16·6	D.	17·2
Length of head	6·2	8·4	9·4	13·1	14·1	14·0	14·8	15·1	14·9	11·2	15·7
Width of head	4·9	6·6	8·0	12·0	12·8	12·1	11·6	13·1	13·8	9·2	14·9
Height of head	3·0	3·9	4·8	7·1	6·7	7·1	6·9	6·8	7·4	5·1	8·0
Length of snout	3·1	4·0	5·2	7·8	7·5	7·9	7·9	8·6	8·4	6·2	9·0
Diameter of eye	1·6	1·9	2·0	2·9	2·9	2·6	2·5	2·7	3·0	2·4	3·1
Interorbital width	2·2	2·8	3·0	5·0	5·1	5·0	5·0	5·2	5·5	3·6	5·6
Depth of body	2·9	4·2	6·1	11·0	10·0	9·1	9·2	9·0	10·2	6·0	10·3
Width of body	4·0	5·6	7·9	13·2	12·4	12·9	10·9	12·3	13·1	9·1	13·9
Length of caudal peduncle	3·1	6·4	8·0	10·3	10·6	11·5	10·8	12·8	11·0	9·0	12·7
Least height of caudal peduncle	2·0	2·8	4·1	7·0	6·1	6·0	6·4	7·1	7·4	4·5	6·8
Length of pectoral	7·1	9·7	11·0	16·3	18·7	18·6	19·8	20·0	18·8	14·5	21·6
Length of ventral	4·2	8·2	9·0	15·2	15·9	16·0	17·7	17·8	16·1	12·1	19·3
Longest ray of dorsal	5·4	7·6	9·0	13·0	14·7	13·1	13·9	14·4	14·4	10·7	17·5
Longest ray of anal	3·6	5·6	5·9	9·8	10·0	9·6	10·0	10·8	11·5	8·6	12·4

on the head and on the ventral surface as far as the anal opening. There are about 70 to 75 scales along the lateral line. In some specimens, the scales in the anterior region are slightly keeled. The number of predorsal scales is about 30 and there are about 12 to 15 rows of scales above the lateral line and 9 to 10 below it to the base of the pelvic fins. The anal opening is situated in a shallow groove which runs in the mid-ventral line between the bases of the pelvic and anal fins.

The dorsal fin is short and commences slightly behind the pelvics; it is considerably higher than the depth of the body. The commencement of the dorsal fin is nearer to the tip of the snout than to the base of the caudal fin. The anal is similar to the dorsal and commences nearer to the base of the caudal than to that of the pelvic. The paired fins are broad, wing-like and horizontal. The pectorals commence just behind the eyes, are longer than the head and extend almost to the bases of the pelvics. The pelvic fins are similar to the pectorals and, except in very young specimens, are longer than the head; they may or may not extend as far as the anal opening but are separated from the anal fin by a considerable distance. The caudal fin is forked with the lower lobe considerably longer than the upper: except in the young examples, it is longer than the head.

The basipterygium (Pl. VIII, fig. 2) conforms to the Homalopterinae type; it is devoid of lateral horns and is provided with a lateral foramen. The pharyngeal teeth (Pl. VIII, fig. 3) are uniserial, those in the middle of the slender bone are larger. There are about 13 teeth.

The body and the fins are covered with spots which are irregularly distributed on the body while they form regular rows on the fins. In most of the specimens the dorsal surface is dark so the black spots do not show off well, but in the three specimens from Kallar Stream near Trivandrum the ground colour is considerably lighter and in consequence the spots are very prominent.

Distribution.—In the synonymy, localities from which this species has so far been recorded are given. I have now examined more specimens from the Sethumudai Hills, Mysore; Kallar Stream, near Trivandrum, Travancore, and from streams within a radius of 5 miles of Pampadampara, Travancore. It would thus appear that the species is so far known from the hills in the extreme south of Peninsular India.

Travancoria, gen. nov.

The head and the anterior part of the body are greatly depressed and the ventral surface in front of the anal fin is flattened. The snout is narrowly rounded in front and the fishes resemble the narrow-headed forms of *Balitora brucei* Gray described by me[1] from Burma. The eyes are small, dorso-lateral in position and are provided with free orbital margins; they are not visible from the ventral surface. The mouth is small, inferior, transverse and greatly arched. The lips are full, plain and continuous round the angles of the mouth; the middle part of the posterior lip is separated from the two lateral parts and is followed by two well-developed papillae which may appear as short barbels in

[1] Hora, S. L., *Mem. Ind. Mus.* XII, p. 291, pl. x, fig. 6; pl. xi, fig. 6 (1932).

certain specimens. The anterior jaw is covered by the lip, but the posterior jaw is naked, shovel-like, sharp, strong and covered with a horny substance. In front of the mouth there is a deep groove which is bordered anteriorly by the rostral fold and is continued backwards round the angles of the mouth as well as laterally to the sides of the head; the portion of the groove between the maxillary barbel and the side of the head is partly covered by a hood-like extension of the rostral fold. There are four short and stumpy rostral barbels, and in between these the rostral fold is produced into 3 barbel-like projections. However, the form and arrangement of the barbel-like projections of the rostral fold varies considerably in the specimens examined by me. A pair of similar barbels (maxillary barbels) is situated at the angles of the mouth. The gill-opening is oblique and extends in front of the base of the pectoral fin to the ventral surface for a short distance. The body is covered with small scales which are absent on the head and on the ventral surface in front of the anal fin; some of the anterior scales on the dorsal surface are provided with simple short keels which are continued forwards on the head as series of tubercles. The dorsal and the anal fins are short; the former is almost opposite to the pelvic fins. The paired fins are broad and horizontal. The pectoral fin is pedunculate and commences considerably behind the eyes; it almost reaches the pelvic which extends considerably beyond the anal opening. The body becomes broader posteriorly from behind the bases of the pectorals and is broadest just in front of the pelvics. The pectoral is provided with 15-16 rays of which 6 anterior rays are simple. The pelvic possesses 8-9 rays, of which 2 are simple. The caudal peduncle is well formed. The caudal fin is forked with the lower lobe considerably longer than the upper.

Genotype.—*Travancoria jonesi*, gen. *et* sp. nov.

Relationships.—This remarkable genus is intermediate in certain characters between *Homaloptera* van Hass. and *Balitora* Gray, while it has special features of its own which distinguish it from all the other genera of the Homalopterinae. In the form of the body it resembles certain varieties of *Balitora*, but fewer simple rays in the pectoral fins, simple lips, form of the rostral groove and the barbel-like projections on the anterior rostral fold help to distinguish the two genera. From *Homaloptera*, it differs in the possession of a rostral groove and the additional 3 barbels on the rostral fold. In having a posteriorly forked rostral groove, the new genus resembles *Parhomaloptera* Vaillant which belongs to the Gastromyzoninae. The only other genus of the Homalopterinae in which the pelvic fins are provided with two simple rays is *Sinohomaloptera* Fang; it possesses a rostral groove but its lips are papillated, there are two barbels at each angle of the mouth and the pectoral fins are provided with 7-8 simple anterior rays. In the new genus, the structure of the lips, especially of the lower, the form of the rostral groove, lepidosis, tubercles on the head, and the presence of two papillae behind the lower lip are suggestive of *Bhavania* Hora, but in the latter the gill-openings are restricted above the bases of the pectoral fins, whereas in *Travancoria* they extend in front of the pectoral fin to the ventral surface for a short distance.

Travancoria jonesi, gen. et sp. nov.

Plate VIII, figs. 5-9.

D. 2/7-8; A. 1/4-5; P. 3/9-10; V. 2/6-7; C. 17; L.l. 75-77.

Travancoria jonesi is a well-built loach of moderate size in which the head and the greater part of the body are depressed while the tail is somewhat compressed from side to side. The ventral surface is greatly flattened up to the commencement of the anal fin and thereafter the ventral profile rises gradually to the base of the caudal fin. The dorsal profile is gently arched, the greatest height of the body being in front of the dorsal fin. The head is broadly pointed anteriorly, and is covered with series of short, hard, spine-like growths: its length is contained from 5·0 to 5·83 times in the standard length and from 5·93 to 6·83 times in the total length. The width of the head is contained from 1·09 to 1·33 times and its height at the occiput from 1·71 to 1·88 times in its length. The eyes are of moderate size, approximated dorsally and situated in the posterior half of the head; they are not visible from the ventral surface. The diameter of the eye is contained from 4·13 to 5·00 times in the length of the head, from 2·42 to 2·68 times in the length of the snout and from 1·42 to 1·50 times in the interorbital width. The nostrils are situated close to the anterior border of the eye; the anterior nostril is situated in a flap which covers the posterior nostril. The mouth is small, inferior, semicircular and horizontal; the gape of the mouth is about one-fifth of the width of the head. The lips are well developed and free from the jaws; the anterior lip covers the jaw while the posterior lip leaves a considerable part of the jaw bare. Both the lips are continuous at the angles of the mouth, but the median part of the posterior lip is pinched off and is followed by two prominent papillae. The jaws are hard and covered with a horny substance; the posterior jaw is rounded and shovel-like. Between the anterior lip and the rostral fold there is a deep groove which becomes bifurcated near the base of the maxillary barbel; the inner branch is continued round the corner of the mouth while the outer branch extends to the side of the head. There are 6 short stumpy barbels, 4 rostral and 2 maxillary, but in between the bases of the rostral barbels the rostral fold is produced into three barbel-like processes. At the side of the maxillary barbel, the rostral fold forms a lappet which is indented or crenulated. The gill-openings are small but extend to the ventral surface for a short distance; the part of the gill-opening above the base of the pectoral fin is provided with a broad and thick gill-membrane.

The depth of the body is contained from 8·33 to 8·70 times in the standard length and from 9·87 to 10·15 times in the total length. The body is broadest in front of the pelvic fins where it is almost as broad as or somewhat broader than the width of the head. The caudal peduncle is strong and whip-like; its least height is contained from 2·27 to 2·72 times in its length. The body is covered with small scales which are absent on the head and on the ventral surface as far as the anal opening. There are about 75-77 scales along the lateral line, 9 rows above it to the base of the dorsal fin and 9 rows of somewhat smaller scales below it to the base of the pelvic fin. There are about 20 predor-

sal scales. The dorsal and lateral scales in the anterior region are slightly keeled in the middle; the keels become less prominent posteriorly. The anal opening is situated in a shallow groove which runs in the midventral line between the bases of the pelvic and anal fins.

The dorsal fin is short and commences almost opposite or slightly behind the pelvics: it is considerably higher than the depth of the body. The commencement of the dorsal fin is considerably nearer to the tip of the snout than to the base of the caudal fin. The anal fin is similar to the dorsal and commences somewhat nearer to the base of the caudal fin than to that of the pelvic. The paired fins are broad, wing-like and horizontal; the pectorals commence behind the eyes and are longer than the head: they miss the bases of the pelvics by a short distance; the pelvics are similar to the pectorals and are almost as long as the head: they extend considerably beyond the anal-opening but are separated from the anal fin by a considerable distance. The caudal fin is almost as long as the head and is forked in the posterior third of its length; both the lobes are rounded and the lower lobe is better developed and longer than the upper.

The form and structure of the basipterygium (Pl. VIII, fig. 8) and nature of the pharyngeal bone and teeth (Pl. VIII, fig. 9) are similar to those described above for *Bhavania australis.*

The body is dark above and pale below in the flattened part. Along the dorsal surface there is a series of 8-10 broad, saddle-shaped spots, while the head and the sides of the body are mottled with black spots of different sizes and pattern, some of which form a black band along the lateral line. All the fins are provided with series of spots, especially along the middle.

Type-specimen.—F. 13507/1, Zoological Survey of India (*Ind. Mus.*), Calcutta.

Locality.—Streams within a radius of 5 miles of Pampadampara, Peerumedu Taluq, Travancore.

I have great pleasure in associating the name of this remarkable new loach with that of Mr. S. Jones, who sent a fine collection of fish from Travancore to the Zoological Survey of India.

Measurements in millimetres.

Standard length	59 1	62·9	70·0	75·0	87·0
Length of caudal	10·6	11·1	12·0	14·0	14·5
Length of head	11·2	12·2	12·0	15·0	16·0
Width of head	9·4	9·6	11·0	13·0	12·0
Height of head	6 8	6·6	7·0	8·0	8 5
Length of snout	6·3	6·9	7·8	8·0	8·5
Diameter of eye	2·2	2·6	2·9	3·0	3·5
Interorbital width	3·6	3·9	4·2	4·5	5·0
Depth of body	7·0	7·9	8·3	9·0	10·0
Width of body	8·6	10·2	11·0	13·0	14·0
Length of caudal peduncle	10·1	11·0	12·1	12·5	15·0
Least height of caudal peduncle ..	3·8	4·1	4·6	5·5	5·5
Length of pectoral	12·2	14·6	14·2	16·5	19·0
Length of ventral	11·5	11·6	12·1	14·5	15·0
Longest ray of dorsal	10·9	11·9	12·3	12·5	14·0
Longest ray of anal	8·1	8·7	10·1	10·0	11·0

Balitora brucei var. **mysorensis,** nov.

Plate VIII, fig. 4.

D.3/9 ; A.2/5 : P.9/12 ; V.2/9 ; C.19.

The new variety of *Balitora brucei* from the Mysore State is represented by a single specimen about 2 inches in length. In its slender body and more elongate head it shows great affinity to *B. brucei* var. *burmanicus* Hora[1], but as the material of the new variety is inadequate it is not possible to institute a detailed comparison between the two varieties. On geographical grounds alone, it has been considered advisable to keep the variety from Peninsular India separate from that of Burma, at least for the time being.

The head is contained 4·36 times in the standard length and 5·61 times in the total length. The width of the head is contained 1·41 times and its height at occiput 2·23 times in its length. The diameter of the eye is contained 5·56 times in the length of the head, 3·44 times in the length of the snout and 1·81 times in the interorbital width. The depth of the body is contained 7·61 times in the standard length and 9·84 times in the total length. The caudal peduncle is almost 3 times as long as high.

In general facies, lepidosis, form of fins, mouth, lips, etc. this variety agrees with the *forma typica* and other varieties of the species.

The colour in spirit is olivaceous above with a series of 7 short, broad, saddle-shaped bands of gray colour along the back. On the head between the eyes and the occiput there is a pear-shaped dark mark. Along the lateral line there is a diffuse gray band. The ventral surface is dirty white.

Locality.—Sivasamudram (alt. 1,500—2,000 ft.), Mysore State.

Type-specimen.—F. 13512/1, Zoological Survey of India (*Ind. Mus.*), Calcutta.

Measurements in millimetres.

Standard length	38·8
Length of caudal	11·4
Length of head	8·9
Width of head	6·3
Height of head	4·0
Length of snout	5·5
Diameter of eye	1·6
Interorbital width	2·9
Depth of body	5·1
Width of body	6·2
Length of caudal peduncle	6·2
Least height of caudal peduncle	2·1
Length of pectoral	10·2
Length of ventral	8·9
Longest ray of dorsal	8·0
Longest ray of anal	7·0

[1] Hora, S. L., *Mem. Ind. Mus.* XII, p. 291, pl. xi, fig. 6 (1932).

EXPLANATION OF PLATE VIII.

Homalopterid Fishes from Peninsular India.

Bhavania australis (Jerdon).

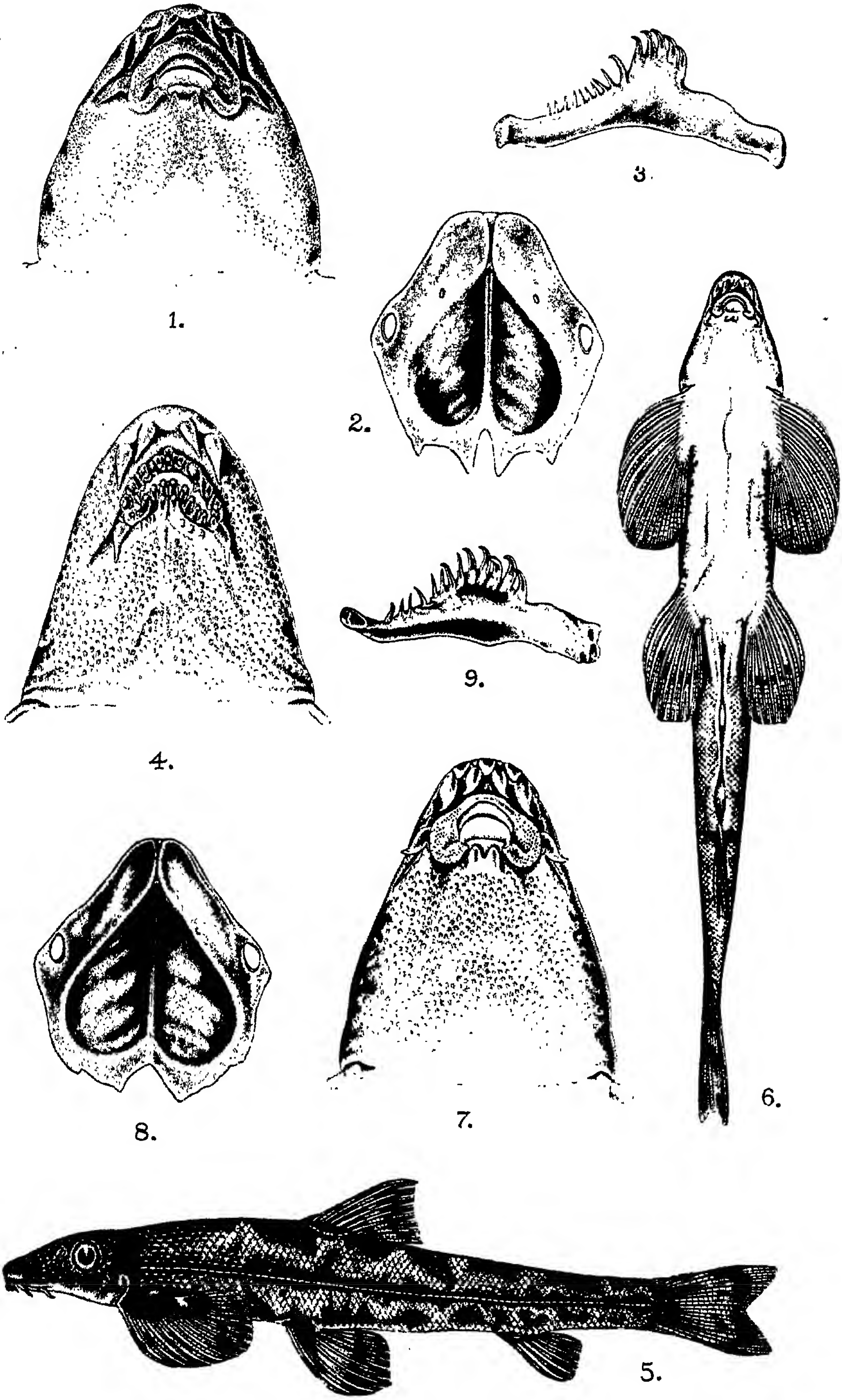
FIG. 1.—Ventral surface of head: $\times 4$.
FIG. 2.—Basipterygium: $\times 3\frac{3}{4}$.
FIG. 3.—Pharyngeal bone and teeth: $\times 13$.

Balitora brucei var. *mysorensis*, nov.

FIG. 4.—Ventral surface of head: $\times 7\frac{1}{2}$.

Travancoria jonesi, gen. *et* sp. nov.

FIG. 5.—Lateral view: $\times 1\frac{7}{8}$.
FIG. 6.—Ventral view: $\times 1\frac{7}{8}$.
FIG. 7.—Ventral surface of head: $\times$ *ca.* $4\frac{3}{4}$.
FIG. 8.—Basipterygium: $\times 3\frac{3}{4}$.
FIG. 9.—Pharyngeal bone and teeth: $\times 13$.



R. Bagchi &
B. N. Bagchi, del.

Homalopterid Fishes from Peninsular India.

THE FRESHWATER FISH OF TRAVANCORE.

By Sunder Lal Hora, *D.Sc., F.R.S.E.. F.N.I., Assistant Superintendent, Zoological Survey of India. Calcutta, and* Nirmal Chandra Law, *M.Sc.*

(Plate IX.)

Contents.

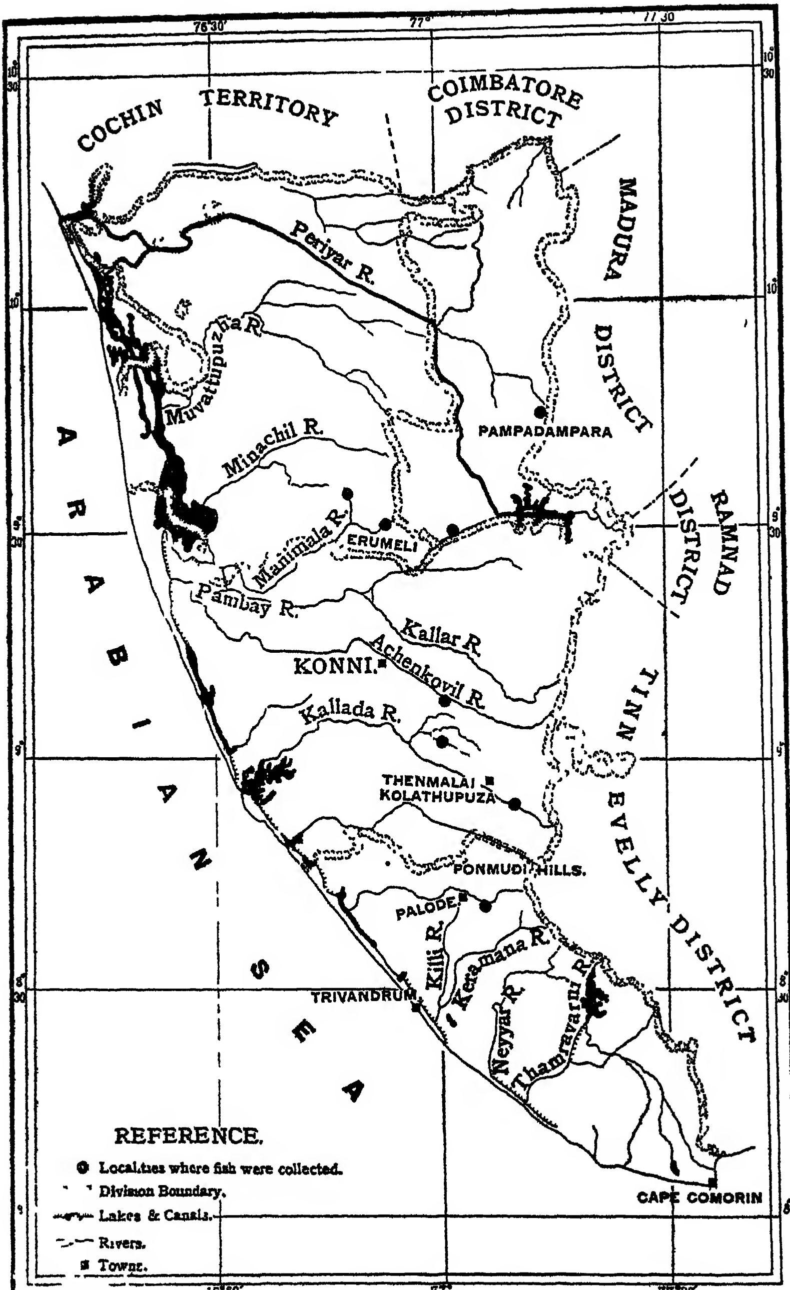
Introduction.

The freshwater fish of Travancore are particularly interesting on account of the zoogeographical peculiarities of some of the forms. An account of the geography of the country, in so far as it affects the aquatic fauna, will be found in John's[1] account of ' Freshwater Fish and Fisheries of Travancore '. It may be well, however, to reiterate here that Travancore lies in the extreme southwest of Peninsular India between 8° 4′ and 10° 21′ N. and 76° 14′ and 77° 73′ E., and that its eastern boundary is formed by a continuous range of hills. The total area of the State is 7,625 square miles, of which 3,547 square miles comprise the up-country reaching an altitude ranging from 4,000 to 8,000 feet above sea level, 2,707 square miles comprise mid-country and the remaining 1,371 square miles constitute the low-country. The hill ranges of Travancore are in reality spurs of the Western Ghats and as they stand like a wall behind the narrow coastal plains they obstruct the south-west monsoon and in consequence the rainfall is heavy between the months of May and August. There is a certain amount of rainfall during the north-east monsoon also. The maximum annual rainfall is about 200 inches.

Owing to the mountainous character of the country and the heavy rainfall, both during the summer and winter months, there is a large number of perennial torrential streams harbouring remarkable forms adapted for life in swift currents. With a view to study the fish-fauna of such waters, one of us requested Mr. S. Jones and Dr. C. C. John to collect for the Zoological Survey of India a representative lot of hill-stream fishes from different parts of the State. They very kindly undertook the work and the collection under report was made by them from the following localities :—

1. Pampadampara Tank, North Travancore.
2. Streams within a radius of about 5 miles round Pampadampara, North Travancore.
3. Dhobikana, a small stream close to Pampadampara, North Travancore.
4. Sannyasa-ode, near Pampadampara, North Travancore.

[1] John, C. C., *Journ. Bombay Nat. Hist. Soc.* XXXVIII, pp. 702-733 (1936).



TEXT-FIG. 1.—Map of Travancore showing localities in which the fish were collected by Mr. S. Jones and Dr. C. C. John.

5. Manimala R., near Kangirappally, Central Travancore.
6. A tributary of Manimala R., Erumeli, Central Travancore.
7. Pool at the foot of the largest fall of Perunthenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore.
8. Achenkovil R., 7 miles south-east of Konni, Central Travancore.
9. Near the source of Kallada R., 4 miles east of Thenmalai, Central Travancore
10. Kulathupuzha, a tributary of Kallada R., Central Travancore.
11. Kallar stream at the foot of Ponmudi Hills, South Travancore.
12. Chittar stream at Palode, South Travancore.
13. Trivandrum. South Travancore.

With the exception of the Kallar stream, Mr. Jones's collection was made from streams in North Travancore, while Dr. John sent the material from the southern and central parts of the State. The collection under report is, therefore, fairly representative of the hill-stream fish-fauna of the State. Further search is, however, likely to reveal more forms from similar habitats. As one new genus and two new species have been found in the material collected by Mr. Jones and Dr. John there is every likelihood of more new species being found among the smaller forms that live under rocks and stones in torrential streams. Attention may also be directed to the fact that recently Raj[1] has described a new genus of Schizothoracine fishes from the Periyar Lake, Travancore.

The material is in an excellent state of preservation which shows that great care must have been taken in handling the specimens in the field. We wish to express here our great indebtedness to Mr. S. Jones and Dr. C. C. John for making the collection and presenting it to the Zoological Survey of India. A duplicate set of the material has been sent to the Government Museum, Trivandrum.

In January 1941, Dr. A. W. C. T. Herre of the Stanford University, California, visited Travancore and made a collection of fish. He presented to the Zoological Survey of India a few specimens obtained by him from the Kallar stream, 30 miles north-east of Trivandrum. The following species are represented in this lot:—

1. *Barilius gatensis* (Cuv. & Val.).
2. *Barbus* (*Puntius*) *amphibius* (Cuv. & Val.).
3. *Barbus* (*Puntius*) *melanampyx* (Day).
4. *Garra mullya* (Sykes).
5. *Bhavania australis* (Jerdon).
6. *Nemachilus triangularis* (Day).
7. *Mastacembelus armatus* (Lacép.).

The first comprehensive list of 369 species of the fishes of Travancore was published by Pillay[2], but he remarked that the list would probably be greatly augmented if the marine, brackish and fresh waters of the State could be systematically investigated. His list contains 72 freshwater species. John (*loc. cit.*) gave a list of 73 species but though he had included practically all the freshwater fishes listed by Pillay, he omitted to include, without comments, *Barilius bakeri*, *Barbus malabaricus* and *B. wynaadensis* which had already been recorded by Pillay from Travancore. However, he added to the previous list *Anguilla vulgaris*, *Barbus filamentosus*, *B. punctatus* and *B. sarana*. We have not been able to find any reference to the first of these species and presumably the author has confused his determination with the marine

[1] Raj, B. Sundara, *Rec. Ind. Mus.* XLIII, pp. 209-214 (1941).
[2] Pillay, R. S. N., *Journ. Bombay Nat. Hist. Soc.* XXXIII, pp. 347-379 (1929).

fish *Conger vulgaris* Cuvier which is a synonym of *Conger conger* (Linn.). Leaving this species out of consideration and combining the two lists, we have in all 75 species of freshwater fishes recorded from Travancore. Of these *Barbus filamentosus* and *B. mahecola* are synonymous[1] as they represent male and female sexes respectively of the same species (*vide infra*, p. 245). Similarly, *Haplochilus lineatus* and *H. rubrostigma* represent the two sexes of the same species. One of us[2] has shown that *Callichrous malabaricus* is a synonym of *C. bimaculatus*. *Rasbora nilgheriensis*, as noted by Day,[3] is only a colour variety of the widely distributed *R. daniconius*. Thus the total number of freshwater species is reduced to 71. Of these, *Megalops cyprinoides*. *Hemirhamphus xanthopterus*, *Ambassis gymnocephalus*, *Gerres limbatus* and *Gobius striatus* (=*Awaous stamineus*) are mainly marine and brackish water species, though they may frequent fresh waters also. For this reason, it is advisable to exclude them from a list of purely freshwater fishes, the number of which will thus be reduced to 66.

We[4] have described from Dr. John's collection a new Catfish, *Batasio travancoria*, from Central and Southern Travancore, while Raj[5] has more recently described a small-scaled Barbel, *Lepidopygopsis typus*, from the Periyar Lake, and Hora[6] has described from Mr. Jones's collection a Homalopterid loach. *Travancoria jonesi*, from Northern Travancore. Among the material under report we have further found representatives of the following species which were not recorded by Pillay and John: *Barilius gatensis*, *Danio aequipinnatus*, *Rasbora rasbora*, *Barbus mussullah*, *Barbus ticto*, *Garra mullya*, *Lepidocephalus thermalis*, *Nemachilus evezardi*, *N. guentheri*, *Bhavania australis*, *Mystus cavasius* and *Glyptothorax madraspatanus*. Of these, *B. mussullah* probably corresponds to *B. tor* of the lists of Pillay and John; *D. aequipinnatus* to *D. malabaricus*; *B. ticto* to *B. punctatus*; *G. mullya* to *Discognathus lamta* and *B. australis* to *Homaloptera maculata*. Thus, excluding these five species, only 7 additional species are added to the list as a result of our present study. The total number of species now known from the fresh waters of Travancore is 76. As the nomenclature of a number of species is changed, we give below a complete systematic list of the freshwater fishes of Travancore with their up-to-date scientific names and geographical range. For vernacular names reference may be made to the lists published by Pillay and John respectively.

List of the Freshwater Fish of Travancore with their Geographical Range.

The general classification of fishes adopted in the list is that proposed by Dr. C. Tate Regan, F.R.S., in his article on 'Fishes' in the Fourteenth Edition of the *Encyclopaedia Britannica* (1929). The genera under their respective families and the species under each genus are alpha-

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[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 22 (1937).
[2] Hora, S. L., *Rec. Ind. Mus.* XXXVIII, pp. 356-361 (1936).
[3] Day, F., *Fish. India*, p. 584 (1878).
[4] Hora, S. L., and Law N. C., *Rec. Ind. Mus.* XLIII, pp. 40-42 (1941).
[5] Raj, B. Sundara, *Rec. Ind. Mus.* XLIII, p. 209 (1941).
[6] Hora, S. L., *Rec. Ind. Mus.* XLIII, p. 230 (1941).

betically arranged. The species whose name is marked with an asterisk (*) is represented in the collection under report.

List of Species.	Geographical Range.
Order: OSTARIOPHYSI.	
Suborder: *CYPRINOIDEA.*	
Family: CYPRINIDAE.	
Subfamily. *ABRAMADINAE.*	
1. *Chela boopis* Day	Travancore and South Canara.
2. *Laubuca laubuca* (Ham.) ..	Ceylon, India, Burma and Sumatra.
Subfamily: *RASBORINAE.*	
3. *Barilius bakeri* Day	Travancore.
*4. *Barilius gatensis* (C. V.) ..	Western Ghats, Nilgiris and Coorg.
*5. *Danio aequipinnatus* (McClell.) ..	Ceylon, India, Burma and Siam.
*6. *Rasbora daniconius* (Ham.) ..	Ceylon, India, Burma, Siam, Malaya, etc.
*7. *Rasbora rasbora* (Ham.) ..	India, Burma, Siam and Malaya.
Subfamily: *CYPRININAE.*	
8. *Amblypharyngodon melettina* (C. V.)	Ceylon, Peninsular India and Deccan.
9. *Amblypharyngodon microlepis* (Blkr.)	Peninsular India, through Orissa to Hooghly.
10. *Amblypharyngodon mola* (Ham.) ..	India and Burma.
*11. *Barbus (Puntius) amphibius* (C. V.)	Ceylon and Peninsular India.
12. *Barbus (Puntius) arulius* (Jerd.) ..	Peninsular India.
13. *Barbus (Puntius) burmanicus* (Day)	Travancore, Burma and Malaya.
14. *Barbus (Puntius) conchonius* Ham.	India (generally Northern India).
*15. *Barbus (Puntius) curmuca* (Ham.)	Western Ghats.
16. *Barbus (Puntius) denisoni* (Day)	Travancore.
*17. *Barbus (Puntius) filamentosus* (C. V.)	Ceylon and Peninsular India.
18. *Barbus (Puntius) lithopidos* Day	Travancore, South Canara and Coorg.
19. *Barbus (Tor) malabaricus* Jerd.	Travancore and South Canara.
*20. *Barbus (Puntius) melanampyx* (Day)	Peninsular India.
21. *Barbus (Puntius) melanostigma* (Day)	Travancore, Wynaad and Nilgiris.
*22. *Barbus (Tor) mussullah* Sykes ..	Peninsular India, and Deccan.
23. *Barbus (Puntius) parrah* (Day) ..	Peninsular India.
*24. *Barbus (Puntius) pinnauratus* (Day)	Ceylon, Peninsular India, Satpuras, Burma and Siam.
25. *Barbus (Puntius) sarana* (Ham.) ..	India and Burma.
26. *Barbus (Puntius) sophore* Ham.[1]	India, Burma and Yunnan.
*27. *Barbus (Puntius) ticto* Ham. ..	Ceylon, India, Burma and Siam.
28. *Barbus (Puntius) vittatus* (Day) ..	Ceylon, Peninsular India and Cutch.
29. *Barbus (Puntius) wynaudensis* Day	Travancore and Wynaad.
30. *Garra jerdoni* (Day)	Peninsular India.
*31. *Garra mullya* (Sykes) ..	Peninsular India, Satpuras and Kathiawar.
32. *Labeo dussumieri* (C. V.) ..	Ceylon, Peninsular India and Gujarat.
33. *Rohtee bakeri* Day	Travancore.
Subfamily: *SCHIZOTHORACINAE.*	
34. *Lepidopygopsis typus* Raj. ..	Travancore.

[1] This is the same species as *Barbus stigma* (Cuv. & Val.) of the earlier lists. For nomenclatorial change see Chaudhuri, *Mem. Ind. Mus.* V, p. 436 (1916).

List of Species.	Geographical Range.
Family : HOMALOPTERIDAE.	
Subfamily: *HOMALOPTERINAE.*	
*35. *Bhavania australis* (Jerd.)	Travancore, Nilgiris, Wynaad and
*36. *Travancoria jonesi* Hora	Travancore.
Family : COBITIDAE.	
*37. *Lepidocephalus thermalis* (C. V.)	Ceylon and Peninsular India.
38. *Nemachilus botia* (Ham.)	Ceylon, India and Burma.
*39. *Nemachilus evezardi* Day	Peninsular India and Deccan.
*40. *Nemachilus guentheri* Day	Travancore and Nilgiri Hills.
*41. *Nemachilus triangularis* Day	Travancore.
Suborder : *SILUROIDEA.*	
Family : CLARIIDAE.	
42. *Clarias batrachus* (Linn.)	India, Burma, Siam, Malaya and further east.
Family : HETEROPNEUSTIDAE.	
43. *Heteropneustes fossilis* (Bloch)	Ceylon, India, Burma, Siam and Cochin-China.
Family : SILURIDAE.	
*44. *Callichrous bimaculatus* (Bloch)	Ceylon, India, Burma and further east.
45. *Wallagonia attu* (Bloch)	Ceylon, India, Burma, Siam, Malay Peninsula and Western Yunnan.
Family : SCHILBEIDAE.	
46. *Pseudeutropius sykesi* (Jerd.)	Peninsular India.
Family : BAGRIDAE.	
*47. *Batasio travancoria* Hora & Law	Travancore.
*48. *Mystus cavasius* (Ham.)	India, Burma and Siam.
49. *Mystus chryseus* (Day)	Travancore, Canara and Malabar.
50. *Mystus gulio* (Ham.) ..	Ceylon, India, Burma and Malaya.
*51. *Mystus malabaricus* (Jerd.)	Travancore, Malabar and Wynaad.
52. *Mystus montanus* (Jerd.)	Travancore, Wynaad and Cauvery R.
53. *Mystus oculatus* (C. V.)	Travancore, Malabar and Nilgiris.
54. *Mystus vittatus* (Bloch)	Ceylon, India, Burma and Siam.
Family : SISORIDAE.	
*55. *Glyptothorax madraspatanus* (Day)	Travancore, Nilgiris, and Mysore.
Order : APODES.	
Family : ANGUILLIDAE.	
56. *Anguilla bicolor* McClelland	Africa, India and further east.
Order : SYNENTOGNATHI.	
Suborder : *SCOMBRESOCOIDEA.*	
Family : XENENTODONTIDAE or BELONIDAE.	
*57. *Xenentodon cancila* (Ham.)	Ceylon, India, Burma, Malaya and Siam.
Order : MICROCYPRINI.	
Family : CYPRINODONTIDAE.	
58. *Aplochilus lineatus* (C. V.)	Ceylon, Peninsular India and Deccan.
Order : PERCOMORPHI.	
Suborder : *PERCOIDEA.*	
Family : AMBASSIDAE.	
59. *Ambassis dayi* Blkr. ..	Travancore and Malabar.
60. *Ambassis nalua* (Ham.)	Travancore, Malabar, Calcutta, Andamans and Malay Archipelago.
61. *Ambassis thomassi* Day	Travancore, Malabar, Siam and Malaya.

List of Species.	Geographical Range.
Family: NANDIDAE.	
62. *Nandus nandus* (Ham.)	.. India, Burma, Siam and Malaya.
Family: PRISTOLEPIDAE.	
63. *Pristolepis fasciata* (Blkr.)	.. Travancore, Burma, Siam, Malay Archipelago and Cochin-China.
64. *Pristolepis malabarica* (Gthr.)	.. Southern part of Western Ghats.
Family: CICHLIDAE.	
65. *Etroplus maculatus* (Bloch)	.. Ceylon and Peninsular India.
66. *Etroplus suratensis* (Bloch)	.. Ceylon, Peninsular India and Deccan.
Suborder: *GOBIOIDEA.*	
Family: GOBIIDAE.	
67. *Glossogobius giuris* (Ham.)	.. Ceylon, India, Burma and further east.
Suborder: *ANABANTOIDEA.*	
Family: ANABANTIDAE.	
68. *Anabas testudineus* (Bloch)	.. Ceylon, India, Burma and further east.
Family: POLYCANTHIDAE.	
69. *Macropodus cupanus* C. V.	.. South India, Malay Peninsula and Sumatra.
Suborder: *OPHICEPHALOIDEA.*	
Family: OPHICEPHALIDAE.	
70. *Ophicephalus gachua* Ham.	.. Ceylon, India, Burma and further east.
71. *Ophicephalus leucopunctatus* Sykes	Peninsular India and Deccan.
72. *Ophicephalus marulius* Ham.	.. Ceylon, India, Burma to China.
73. *Ophicephalus micropeltes* (K. & V. Hass.) C. V. ..	.. Western Coast of India, Malay Archipelago, Siam and Indo-China.
74. *Ophicephalus striatus* Bloch	.. Ceylon, India, Burma and further east.
Order: OPISTHOMI.	
Family: MASTACEMBELIDAE.	
*75. *Mastacembelus armatus* (Lacép.)	.. Ceylon, India, Burma and further east.
76. *Mastacembelus guentheri* Day	.. Travancore, Malabar and Malaya.

As is to be expected, a great majority of the species belong to the Ostariophysi, 41 to the Suborder Cyprinoidea and 14 to the Suborder Siluroidea. Of the remaining 21 species, 1 belongs to Apodes (Anguillidae), 1 to Synentognathi (Belonidae), 1 to Microcyprini (Cyprinodontidae), 16 to Percomorphi (Ambassidae 3; Nandidae 1; Pristolepidae 2; Cichlidae 2; Gobiidae 1; Anabantidae 1: Polycanthidae 1; Ophicephalidae 5) and 2 to Opisthomi (Mastacembelidae).

ZOOGEOGRAPHICAL REMARKS.

With the exception of the Cichlidae, which are confined to Peninsular India and Ceylon, the remaining families listed above are widely distributed in the Oriental Region and even further afield. The Cichlidae represent the Ethiopean element in the fish-fauna of India[1]. The Schizothoracinae, which are the dominant fish of the streams, marshes and lakes of the high plateau of Central Asia, represent the Palaearctic

[1] Hora, S. L., *Curr. Sci.* V, p. 354 (1937).

element in the fauna of Peninsular India. Two genera of the Schizothoracinae, *Schizothorax* Heckel and *Oreinus* McClelland, are found in torrential streams along the southern slopes of the Himalayas, but nowhere else in India. The occurrence of *Lepidopygopsis* in the Periyar Lake is, therefore, of special zoogeographical significance. Similarly the Homalopteridae, which are represented in Travancore by two genera of the Homalopterinae are of particular interest. The Homalopteridae are represented by a number of genera in south-eastern Asia and in India proper their range extends up to the hill ranges of Assam and Chittagong, and the Eastern Himalayas; they are absent from the rest of India with the exception of the southern parts of the Western Ghats. The same can be said with regard to the distribution of *Batasio* Blyth. The genera *Macropodus* Lacépède and *Pristolepis* Jerdon are either found in Peninsular India or in the Far East. There are species in the fauna of Travancore, such as *Mastacembelus guentheri*, *Barbus* (*Puntius*) *burmanicus*, *Ambassis thomassi*, and *Ophicephalus micropeltes*, which show a similar discontinuity in the respective ranges of their distribution. Even if individuals of a single species are considered, we find that specimens of *Barbus* (*Puntius*) *ticto* with the lateral line complete are either found in Peninsular India or in Burma and Siam. There is thus a great deal of evidence to show the close relationship of the Malayan fauna with that of Peninsular India.

The freshwater fish-fauna of Travancore can be divided into the following groups from a zoogeographical point of view:

Group I.—*Species distributed throughout India, Burma and further east.*

1. *Laubuca laubuca* (Ham.).
2. *Danio aequipinnatus* (McClell.).
3. *Rasbora daniconius* (Ham.).
4. *Rasbora rasbora* (Ham.).
5. *Amblypharyngodon mola* (Ham.).
6. *Barbus* (*Puntius*) *pinnauratus* (Day).
7. *Barbus* (*Puntius*) *sarana* (Ham.).
8. *Barbus* (*Puntius*) *sophore* Ham.
9. *Barbus* (*Puntius*) *ticto* Ham.
10. *Nemachilus botia* (Ham.).
11. *Clarias batrachus* (Linn.).
12. *Heteropneustes fossilis* (Bloch).
13. *Callichrous bimaculatus* (Bloch).
14. *Wallagonia attu* (Bloch).
15. *Mystus cavasius* (Ham.).
16. *Mystus gulio* (Ham.).
17. *Mystus vittatus* (Bloch).
18. *Anguilla bicolor* McClell.
19. *Xenentodon cancila* (Ham.).
20. *Ambassis nalua* (Ham.).
21. *Nandus nandus* (Ham.).
22. *Anabas testudineus* (Bloch).
23. *Glossogobius giuris* (Ham.).
24. *Ophicephalus gachua* Ham.
25. *Ophicephalus marulius* Ham.
26. *Ophicephalus striatus* Bloch.
27. *Mastacembelus armatus* (Lacép.).

Group II.—*Species distributed in Peninsular India, Malay Peninsula etc.*

1. *Barbus* (*Puntius*) *burmanicus* Day.
2. *Ambassis thomassi* Day.
3. *Ophicephalus micropeltes* C. V.
4. *Pristolepis fasciata* (Blkr.).
5. *Macropodus cupanus* C. V.
6. *Mastacembelus guentheri* Day.

Group III.—*Species distributed throughout India.*

1. *Barbus* (*Puntius*) *conchonius* Ham.

Group IV.—*Species with restricted distribution in India.*

1. *Amblypharyngodon microlepis* (Blkr.).
2. *Barbus (Tor) mussullah* Sykes.
3. *Garra mullya* (Sykes).
4. *Nemachilus evezardi* Day.

Group V.—*Species common to Peninsular India and Ceylon.*

1. *Amblypharyngodon melettina* (C. V.).
2. *Barbus (Puntius) amphibius* (C. V.).
3. *Barbus (Puntius) filamentosus* (C. V.).
4. *Barbus (Puntius) vittatus* (Day).
5. *Labeo dussumieri* (C. V.).
6. *Lepidocephalus thermalis* (C. V.).
7. *Aplocheilus lineatus* (C. V.).
8. *Etroplus maculatus* (Bloch).
9. *Etroplus suratensis* (Bloch).

Group VI.—*Species distributed throughout Peninsular India.*

1. *Barbus (Puntius) arulius* (Jerd.).
2. *Barbus (Puntius) melanampyx* (Day).
3. *Barbus (Puntius) parrah* (Day).
4. *Garra jerdoni* (Day).
5. *Pseudeutropius sykesi* (Jerd.).
6. *Ophicephalus leucopunctatus* Sykes.

Group VII.—*Species found in the Western Ghats and associated hills.*

1. *Chela boopis* Day.
2. *Barilius gatensis* (C. V.).
3. *Barbus (Puntius) curmuca* (Ham.).
4. *Barbus (Puntius) lithopidos* Day.
5. *Barbus (Tor) malabaricus* Jerd.
6. *Barbus (Puntius) melanostigma* (Day).
7. *Barbus (Puntius) wynaadensis* Day.
8. *Bhavania australis* (Jerd.).
9. *Nemachilus guentheri* Day.
10. *Mystus chryseus* (Day).
11. *Mystus malabaricus* (Jerd.).
12. *Mystus montanus* (Jerd.).
13. *Mystus oculatus* (C. V.).
14. *Glyptothorax madraspatanus* (Day).
15. *Ambassis dayi* Blkr.
16. *Pristolepis malabarica* (Gthr.).

Group VIII.—*Species endemic in Travancore.*

1. *Barilius bakeri* Day.
2. *Barbus (Puntius) denisoni* Day.
3. *Rohtee bakeri* Day.
4. *Lepidopygopsis typus* Raj.
5. *Travancoria jonesi* Hora.
6. *Nemachilus triangularis* Day.
7. *Batasio travancoria* Hora & Law.

Of the 76 species listed above, 27 are widely distributed in India, Burma and further east; 6 are found in Peninsular India on the one hand and in Burma and further east on the other, but nowhere else in India; 1 is distributed all over India proper but is not found in Burma: 4 have a restricted distribution in India, mainly in Peninsular India and along the Satpura Trend of mountains; 9 are found in Peninsular India and Ceylon, while the remaining 29 are restricted to Peninsular India and of these 7 are endemic in Travancore. Of the 29 species only known from Peninsular India, as many as 23 are found only in the Western Ghats and the associated hills. If Ceylon and Peninsular India be regarded as one zoogeographical region and the forms, which are found either in Peninsular India or further east but not in other parts of India, be grouped along with the species restricted to Ceylon and Peninsular India, it becomes apparent that about 60 per cent of the species are peculiar to Southern India and are found nowhere else in India proper. This high endemicity of the fauna of this region has been noticed by previous workers also in the case of other groups of animals.

From a zoogeographical point of view, the freshwater fish-fauna of Travancore presents two special features, the marked Malayan element

and the preponderance of endemic forms. The former, according to Blanford[1], dates in India from the Miocene times. We have indicated above the occurrence of the Homalopteridae and of the genus *Batasio* in the hills of Assam and the Eastern Himalayas which indicates the probable route along which the Malayan fauna migrated to Peninsular India. Regarding the Himalayan fauna, Blanford stated that:

> " ....The Indo-Malay element in the fauna is very richly represented in the Eastern Himalayas, and gradually diminishes to the westward, until in Kashmir and further west it ceases to be the principal constituent. Almost all the Indo-Malay genera, and a very large proportion of the species, are identical with Assamese or Burmese forms. These facts are consistent with the theory that the Indo-Malay part of the Himalayan fauna, or the greater portion of it, has migrated into the mountains from the eastward at a comparatively recent period. *It is an important fact that this migration appears to have been from Assam and not from the Peninsula of India.*" (Italics are ours.)

One of us[2] has explained the presence of the Indo-Malayan element in the fauna of the Eastern Himalayas and Peninsular India by postulating that the uplift movement of the Himalayas was probably most active in the region of the Assam Himalayas as practically all the highest peaks are clustered round this area. It was argued that

> " This differential movement, which probably occurred late in the Miocene period, must have obliterated all traces of the eastward extension of the Indobrahm and also acted as a barrier between the eastern and western Himalayan fishes. The new stocks of specialised hill-stream fishes from the east, not finding means to cross this barrier, were deflected towards south-west along the Satpura Trend which probably at this period stretched across India as a pronounced range from Gujarat to the Assam Himalayas. From Gujarat the hill-stream fauna migrated towards the south along the Western Ghats and spread to the hills of the Peninsula in the extreme south."

To account for the anomalies of distribution referred to above. Blanford (*loc. cit.*, p. 435) postulated the diminution of temperature as the cause for the dispersal of animals from the north to the south and stated :

> " ....Unless the temperature of India and Burma generally underwent a considerable diminution, it is not easy to understand how plants and animals of temperate Himalayan types succeeded in reaching the hills of Southern India and Ceylon, as well as those of Burma and Malay Peninsula."

Temperature is undoubtedly a great factor in the dispersal of animals and probably has very great influence on the terrestrial fauna but in the case of aquatic animals the presence of water connections is also an important factor. Moreover, in the case of torrential fishes, such as the Homalopteridae, a rocky substratum and a swift current are also essential for their very existence. In view of these ecological considerations, it seems probable that the Satpura Trend may have acted as a highway for the migration of this fauna from the late Miocene period to the time of formation of the Rajmahal-Garro Hill gap. This movement may have been facilitated by the diminution of temperature if the earth movements of the glacial period provided necessary water connections for the transference of the fauna from the north-east to the south-west.

The high endemicity of the Travancore fauna is an evidence of its antiquity and long isolation from the fauna of the mainland of India and of the adjacent countries. After migrating from north-east to

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[1] Blanford, W. T., *Phil. Trans. Roy. Soc. London* (B) CXCIV, pp. 433, 434 (1921).
[2] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 255 (1937).

south-west, the fauna came to a blind end in the Peninsular region and when, with the formation of the Rajmahal-Garo Hill gap and due to other causes, it became isolated, it had sufficient time to blossom out into distinct species, while still retaining its family affinities with the parent stock.

SYSTEMATIC ACCOUNT.

Barilius gatensis (Cuv. & Val.).

1878. *Barilius gatensis*, Day, *Fish. India*, p. 592, pl. cxlix, fig. 2.

4 specimens, 52 to 108 mm. in length. Streams within a radius of about 5 miles of Pampadampara, Western Ghats, North Travancore. S. Jones, April 1941.

3 specimens, 30 to 39 mm. in length. Manimala R., near Kangirappally, Central Travancore. C. C. John, 26. iii.1940.

2 specimens, 78 and 97 mm. in length respectively. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11. ii.1940.

1 specimen, 72 mm. long. Chittar stream at Palode, South Travancore. C. C. John, 10.ii.1940.

According to Day, *Barilius gatensis* is known from " Western Ghats of Malabar and Neilgherry hills ", but since then its range has been extended to other parts of the Western Ghats also. In some of the specimens under report, the lateral bars are short and form a series of oblong spots along the sides. On the whole it is a brightly coloured species.

Danio aequipinnatus (McClelland).

1878. *Danio aequipinnatus*, Day, *Fish. India*, p. 596, pl. cl, fig. 6.

19 specimens, 28 to 101 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.

2 specimens, 45 and 80 mm. in length. Sannyasa-ode, near Pampadampara, Western Ghats, North Travancore. S. Jones, April 1940.

2 specimens, 44 and 59 mm. in length. Manimala R., near Kangirappally, Central Travancore. C. C. John, 26.iii.1940.

2 specimens, 68 and 75 mm. in length. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.

1 specimen, 91 mm. long. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.

19 specimens, 18 to 74 mm. in length. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.

2 specimens, 66 and 68 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.

3 specimens, 46 to 67 mm. in length. Chittar stream at Palode, South Travancore. C. C. John, 9.ii.1940.

The large number of young, half-grown and adult specimens referred by us to *Danio aequipinnatus* show variation in colouration and scale counts. It seems to us probable that *D. malabaricus* (Jerdon) of Peninsular India and Ceylon, and *D. strigillifer* Myers of North Burma and Peninsular India are synonymous with the North Indian *D. aequipinnatus*. The three forms, as known at present, are rather difficult to distinguish from one another and the material under report helps to bridge over the differences between them.

Rasbora daniconius (Ham.).

1878. *Rasbora daniconius*, Day, *Fish. India*, P. 584, pl. cxlvi, figs. 2, 3.

7 specimens, 33 to 82 mm. in standard length. Pampadampara Tank, Western Ghats, North Travancore. S. Jones, September 1938 and March 1940.
42 specimens, 21 to 102 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940, and April 1941.
2 specimens; longer one 78 mm. in length. Manimala R., near Kangirappally, Central Travancore. C. C. John, 26.iii.1940.

The specimens of *Rasbora daniconius* correspond with Day's variety *neilgherriensis* which is stated to grow to a large size and to possess 34 scales along the lateral line. In all the specimens the lateral band is broad and well marked.

Rasbora rasbora (Ham.).

1878. *Rasbora buchanani*, Day, *Fish. India*, p. 584, pl. cxlv, fig. 10.

2 specimens, 77 and 83 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, April 1941.
2 specimens, 50 and 65 mm. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.
2 specimens, 82 and 94 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.
1 specimen, 84 mm. long. Chittar stream at Palode, South Travancore. C. C. John, 10.ii.1940.

Rasbora rasbora is represented by a number of badly preserved specimens in which the scales have fallen off. The species is widely distributed in India and Burma, though in the fauna of South India it is less common than *R. daniconius*.

Barbus (Puntius) amphibius (Cuv. & Val.).

1878. *Barbus amphibius*, Day, *Fish. India*, p. 574, pl. cxlii, fig. 8.

2 specimens, 36 and 77 mm. in length. Manimala R., near Kangirappally, Central Travancore. C. C. John, 26.iii.1940.
8 specimens, 62 to 70 mm. in length. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.
1 specimen, 88 mm. long. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.
3 specimens, 60 to 80 mm. in length. Near the source of Kallada R., 4 miles east of Thenmalai, Central Travancore. C. C. John, 9.ii. 1940.
4 specimens, 57 to 74 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.
4 specimens, 59 to 70 mm. in length. Chittar stream at Palode, South Travancore. C. C. John, 10.ii.1940.

All the specimens of *Barbus amphibius* listed above are characterised by the possession of a large, well-marked black spot before the base of the caudal fin; in this respect they agree with Day's description of the Malabar examples. According to Day, this species is found in "Central India, Deccan, Bombay and the Western coast of India, Madras and up to the coast as high as Orissa."

B. amphibius is liable to be confused with *B. dorsalis*[1] but the prominent caudal spot and the absence of dorsal and anal spots in *B. amphibius* enable the two species to be distinguished from each other.

Barbus (Puntius) curmuca (Hamilton).

(Plate IX, fig. 1.)

1878. *Barbus curmuca*, Day, *Fish. India*, p. 566, pl. cxli, fig. 1.

3 specimens, 37 to 97 mm. in length. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.

1 specimen, 148 mm. long. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.

3 specimens, 89 to 110 mm. in length. Near the source of Kallada R., 4 miles east of Thenmalai, Central Travancore. C. C. John, 9.ii.1940.

2 specimens, 106 and 113 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.

Barbus curmuca is represented in the collection by a number of young, and half grown specimens. In the largest example under report, the tips of the caudal fin are deep black in colour and proximal to them there are areas of a light colour. The rest of the fin is somewhat grayish. There is a deep black bar behind the gill-opening and in the dorsal half of the body the scales are grayish with lighter margins. The bases of the scales above and below the lateral line are provided with dark spots. The ventral surface is pale olivaceous.

Barbus (Puntius) filamentosus (Cuv. & Val.).

1937. *Barbus filamentosus*, Hora, *Rec. Ind. Mus.* XXXIX, pp. 22-24, text-figs. 8, 9.

6 specimens, 65 to 87 mm. in length. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.

12 specimens, 77 to 109 mm. in length. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.

4 specimens, 63 to 84 mm. in length. Near the source of Kallada R., 4 miles east of Thenmalai, Central Travancore. C. C. John, 9.ii. 1940.

3 specimens, 75 to 128 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. C. C. John, 20.ii.1940.

4 specimens, 70 to 82 mm. in length. Chittar stream at Palode, South Travancore. C. C. John, 10.ii.1940.

Of the 29 specimens of *Barbus filamentosus* collected by Dr. C. C. John from different localities in Travancore as listed above, there are only 6 fully developed males while the remaining examples are either females or juveniles. In the males the number of prolonged filiform rays varies from 3 to 5 and in one specimen the last unbranched ray is also greatly elongated (text-fig. 2). All the males are provided with patches of large tubercles on either side of the snout. These secondary sexual characters are very characteristic features of the species.

As already pointed out by one of us, considerable importance has been attached to the presence or absence of barbels in the individuals of this species. Small barbels, sometimes hidden in the grooves round

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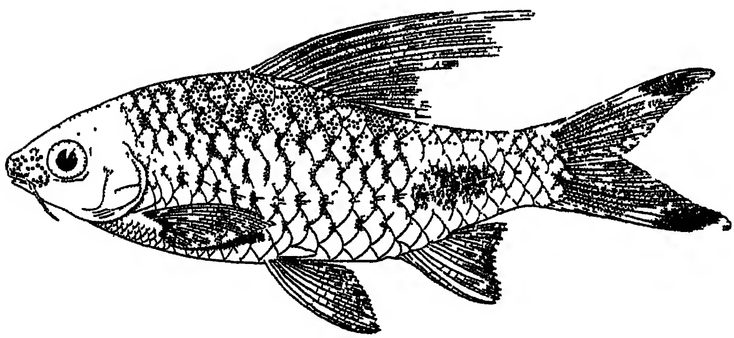
[1] Hora, S. L., *Rec. Ind. Mus.* XXXVIII, pp. 2-5 (1936).

the corners of the mouth, are invariably present in all the specimens, but they seem to vary considerably in length. In smaller individuals



TEXT-FIG. 2.—Lateral view of a mature male specimen of *Barbus* (*Puntius*) *filamentosus* (Cuv. & Val.), showing secondary sexual characters. *Nat. Size.*

they are relatively larger. In one of the male specimens (text-fig. 2) the barbels extend as far back as the posterior border of the eye. In one of the female specimens also the barbels are of the same length, while in two others they extend up to the middle of the eye. One specimen is still more remarkable, for in it the barbel of one side reaches the posterior border of the orbit while that of the other side is very small.

The colour varies considerably with age. In the young specimens the colour marks are not so prominent; the large lateral blotch is, however, fairly well marked and the fins are somewhat dusky. Some of the outer rays of the caudal fin in both the lobes are dark in colour. The bases of the scales are also faintly marked with dark spots. In larger specimens the lateral blotches as also the caudal blotches are intensely black and are surrounded by whitish areas. The black spots at the bases of the scales become somewhat darker, and in males (text-fig. 2) these markings become very prominent. Usually in the males a dark mark is also present behind the gill-opening. The last undivided ray is white in the males and the filamentous prolongations of the rays are somewhat dusky.

Barbus filamentosus is a South Indian species, having been recorded so far from " Canara down the Western coast and along the base of the Neilgherries, and Travancore hills, also Ceylon." It is said to attain at least 6 inches in length.

Barbus (Puntius) melanampyx (Day).

1938. *Barbus melanampyx*, Misra, *Rec. Ind. Mus.* XL, pp. 258-260, 1 text-fig.

30 specimens, 23 to 57 mm. in length. Pampadampara Tank, Western Ghats, North Travancore. S. Jones, September 1938 and March 1940.

52 specimens, 19 to 64 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.

4 specimens, 21 to 37 mm. in length. Manimala R., near Kangirappally, Central Travancore. C. C. John, 26.iii.1940.

1 specimen, 52 mm. long. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.

20 specimens, 22 to 45 mm. in length. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.
1 specimen, 58 mm. long Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.
6 specimens, 25 to 57 mm. in length. Chittar stream at Palode, South Travancore. C. C. John, 10.ii 1940.

Misra (*loc. cit.*) showed that the sexes of *Barbus melanampyx* can be distinguished by their respective colouration. From the large series of fresh specimens examined by us from Travancore we are able to confirm Misra's account, but find that the colouration of the sexes varies to a certain extent. In some of the female specimens the dorsal fin is not stained with black while in some of the smaller examples the three lateral bands are only faintly marked. In a number of male specimens the entire body is dark so that the two broad lateral bands cannot be differentiated from each other. The tips of the caudal fin may be devoid of the usual black colour, and in certain examples the opercular spot is also indistinguishable. In fully mature specimens the tubercles on the snout extend in a broad patch all round the front border of the snout.

Barbus (Tor) mussullah Sykes.

1841. *Barbus mussullah*, Sykes, *Trans. Zool. Soc. London* II, p. 356, pl. lxi, fig 4.

11 specimens, 60 to 260 mm. in length. Streams within a radius of 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.
2 specimens, 42 and 53 mm. in length. Kallar stream at the foot of Ponmudi Hills, Western Ghats, South Travancore. S. Jones, April 1939.

Though Hora in his series of articles on the Game Fishes of India has not yet dealt with the Large-scaled Barbels of Peninsular India, the number of young and half-grown specimens under report seem to belong to *Barbus mussullah*. From a preliminary examination of the material from Peninsular India, Hora has found that this is the commonest species of these parts and that its range extends along the Satpura Trend to the Central Provinces.

Barbus (Puntius) pinnauratus (Day).

1877. *Barbus pinnauratus*, Day, *Fish. India*, p. 561, pl. cxxxix, fig. 3.
1936. *Barbus pinnauratus*, John, *Journ. Bombay Nat. Hist. Soc.* XXXVIII, p. 711.
1937. *Barbus pinnauratus*, Hora, *Rec. Ind. Mus.* XXXIX, p. 336.
1938. *Barbus pinnauratus*, Hora, *Rec. Ind. Mus.* XL, p. 239.
1939. *Barbus pinnauratus*, Das, *Rec. Ind. Mus.* XLI, pp. 440, 441.

1 specimen, 85 mm. long. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.
1 specimen, 111 mm. long. Chittar stream at Palode, South Travancore. C. C. John, 10.ii.1940.

In his recent publications, Hora has referred to the remarkable distribution of *Barbus pinnauratus* and indicated its close similarity to several species known from India and Burma. The specimens under report possess the characteristic colouration of the species and in other respects also represent the typical form.

Barbus (Puntius) ticto Hamilton.

1939. *Barbus (Puntius) ticto*, Hora, Misra & Malik, *Rec. Ind. Mus.* XLI, pp. 263-279.

1 specimen, 32 mm. long. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.

In the paper referred to above, Hora, Misra and Malik adduced evidence to show that Day's *Barbus punctatus* from Peninsular India, characterized by the possession of a complete lateral line, is synonymous with *B. ticto*. In the specimen under report, the lateral line is more or less complete. It is worthwhile to mention here once again that examples of *B. ticto* with complete lateral line have so far been found both in Burma and Siam and in Peninsular India.

Garra mullya (Sykes).

1921. *Garra mullya*, Hora, *Rec. Ind. Mus.* XXII, pp. 658-660.

28 specimens, 63 to 186 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.
10 specimens, 61 to 121 mm. in length. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.
2 specimens, 77 and 87 mm. in length. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.
1 specimen, 45 mm. long. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.
12 specimens, 72 to 114 mm. in length. Near the source of Kallada R., 4 miles east of Thenmalai, Central Travancore. C. C. John, 9.ii.1940.
9 specimens, 71 to 105 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.
2 specimens, 43 and 55 mm. in length. Kallar stream at the foot of Ponmudi Hills, Western Ghats, South Travancore. S. Jones, April 1939.

Garra mullya is the most widely distributed hill-stream fish of the Western Ghats and is represented by a large number of young, half-grown and adult specimens in the collection under report. It has been found to be equally abundant along the western portion of the Satpura Trend of mountains. The species can readily be distinguished by the absence of a proboscis on the snout, by the presence of tubercular areas, and by the fact that the tip of the snout is marked off by two short lateral grooves. In certain examples the tubercles are few and not well marked.

Bhavania australis (Jerdon).

1941. *Bhavania australis*, Hora, *Rec. Ind. Mus.* XLIII, p. 225, pl. viii, figs. 1-3.

12 specimens, 40 to 111 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.
1 specimen, 94·5 mm. long. Kallar stream at the foot of Ponmudi Hills, Western Ghats, South Travancore. S. Jones, April 1939.

Hora (*loc. cit.*) has given a detailed account of *Bhavania australis* and discussed its affinities with other genera of the Homalopterinae. The species seems to be fairly common in the southern portion of the Western Ghats.

Travancoria jonesi Hora.

1941. *Travancoria jonesi*, Hora, *Rec. Ind. Mus.* XLIII, p. 230, pl. viii, figs. 5-9.

20 specimens, 22 to 100 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.

An account of *Travancoria jonesi* was recently published by Hora (*loc. cit.*) in his paper on the Homalopterid fishes from Peninsular India. The genus *Travancoria* is very closely allied to *Bhavania*, but differs in having more extensive gill-openings and a larger number of rostral barbels. The species is known only from Travancore.

Lepidocephalus thermalis (Cuv. & Val.).

1878. *Lepidocephalichthys thermalis*, Day, *Fish. India*, p. 610, pl. clv, fig. 3.

20 specimens, 29 to 33 mm. in length. Pampadampara Tank, Western Ghats, North Travancore. S. Jones, March 1940.

42 specimens, 33·5 to 70 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.

Lepidocephalus thermalis is known from Peninsular India and Ceylon. In general facies, it is closely allied to *L. guntea* of northern India, but Day distinguished the two species by the size of the head and the number of transverse rows of scales on the body. It is likely that when large series of specimens from different localities are carefully examined, the two forms may prove to be local races of the same species.

Nemachilus evezardi Day.

1878. *Nemachilus evezardi*, Day, *Fish India*, p. 613, pl. cliii, fig. 11.
1919. *Nemachilus evezardi*, Annandale, *Rec. Ind. Mus.* XVI, p. 126, pl. i, figs. 2, 2*a*.
1938. *Nemachilus evezardi*, Hora, *Rec. Ind. Mus.* XL, p. 241.

42 specimens, about 25 mm. in length. Streams within a radius of about 5 miles round Pampadampara. Western Ghats, North Travancore. S. Jones, April 1941.

43 specimens, 13 to 56 mm. long. Dhobikana, a small stream close to Pampadampara, Western Ghats, North Travancore. S. Jones, March 1940.

8 specimens, 31 to 41 mm. in length. Sannyasa-ode, near Pampadampara, Western Ghats, North Travancore. S. Jones, April 1940.

Nemachilus evezardi was hitherto known from the Western Ghats, near Bombay, the Pachmarhi hills, Central Provinces, and the Bailadila range, Bastar State, Central Provinces. It is recorded here from the Travancore hills for the first time. The distribution of the species is of some interest as indicating the continuity of these hills at some earlier period.

N. evezardi is readily distinguished from other Indian species of the genus by the possession of well-marked nasal barbels. The colouration is very variable, but is quite characteristic of the species.

Nemachilus guentheri Day.

(Plate IX, figs. 2-5.)

1867. *Nemacheilus guentheri,* Day, *Proc. Zool. Soc. London,* p. 285.
1868. *Nemachilus guentheri,* Günther, *Cat. Fish. Brit. Mus.* VII, p. 361.
1872. *Nemacheilus guentheri,* Day, *Journ. As. Soc. Bengal* XLI, p. 195.
1878. *Nemacheilus guentheri,* Day, *Fish. India,* p. 615, pl. clvi, fig. 10.
1889. *Nemachilus guentheri,* Day, *Faun. Brit. Ind.* Fish. I, p. 228.

2 specimens, 27 and 51·2 mm. in length. Streams within a radius of 5 miles round Pampadampara Western Ghats, North Travancore. S. Jones, April 1941.

Since the discovery of *Nemachilus guentheri* by Day about 74 years ago in the " Rivers along the lower slopes and base of the Neilgherry hills ", no other worker seems to have collected further material of this species. Günther's description is based on a typical specimen from Day's collection. Besides the two specimens collected by Mr. S. Jones as noted above, we have examined 3 specimens from the Dhoni forest in South Malabar collected by Mr. E. Burnes in May 1923, and 8 specimens collected by the late Dr. N. Annandale from the Nierolay stream, a tributary of the Bhavani river at the base of the Nilgiri Hills. These records show that the species is distributed probably all over the southern parts of the Western Ghats and the associated hill ranges.

In the specimens under report, the length of the head is contained from 5·10 to 5·69 times in the total length and from 4·16 to 4·49 times in the standard length. The head is broader than its height : its width is contained from 1·56 to 1·86 times and its height from 1·80 to 2·04 times in its length. The eyes are situated almost in the middle of the head or slightly nearer to the tip of the snout than to the end of the opercular border ; the diameter of the eye is contained from 3·90 to 5·30 times in the length of the head, from 1·43 to 2·25 times in the length of the snout and from 0·83 to 1·40 times in the interorbital width. The head and the anterior part of the body are somewhat flattened while the tail is compressed from side to side. The depth of the body is contained from 8·68 to 9·79 times in the total length and from 6·85 to 7·72 times in the standard length. The caudal peduncle is almost as long as high or may be slightly longer.

From the material before us, it seems that the colouration is very variable. In a specimen from the Dhoni forest, the dorsal surface is uniformly dark with faint indications of the pale bands in the tail region. As pointed out by Day, there are usually three rows of pale spots (Pl. IX, fig. 2) but their extent varies practically with each individual. A black mark is invariably present in the axil of the pectoral fin and the caudal fin is provided with three W-shaped bands across it. There is a deep, short, vertical bar at the base of the caudal fin.

The specimens from the Nierolay stream (Pl. IX, fig. 4) and Pampadampara are much lighter in colour. The general colour of the body is pale olivaceous ; the dorsal surface of the head is grayish, while the entire ventral surface is much lighter. The body is marked with 3 rows of spots of different sizes and form ; they impart a very characteristic appearance to the species.

Measurements in millimetres.

	Dhoni Forest, S. Malabar.			Pampadam-para.	Nierolay Stream, Nilgiris.	
Total length	45·6	51·8	52·0	51·2	40·8	56·8
Length of caudal	9·1	10·6	10·4	10·8	7·2	12·0
Length of head	8·2	9·5	10·0	9·0	8·0	10·6
Height of head	4·1	4·9	4·9	5·0	4·0	5·5
Width of head	5·2	5·1	5·8	5·3	5·0	6·8
Depth of body	5·2	5·6	5·9	5·9	4·9	5·8
Diameter of eye..	2·1	2·1	2·4	2·0	1·8	2·0
Length of snout..	3·0	3·4	3·9	3·9	2·6	4·5
Interorbital distance	2·0	2·5	2·6	2·4	1·5	2·8
Length of dorsal	7·2	9·0	9·8	8·0	7·0	8·5
Length of pectoral	7·2	9·1	9·9	8·9	7·8	10·0
Length of ventral	6·7	8·1	9·0	7·7	6·0	8·9
Length of anal	6·1	7·2	8·1	7·0	5·2	7·7
Length of caudal peduncle	4·6	5·8	5·5	5·0	4·2	5·0
Least height of caudal peduncle ..	4·6	5·0	5·5	4·6	3·8	5·0

Nemachilus triangularis Day.

1865. *Nemacheilus triangularis*, Day, *Proc. Zool. Soc. London*, p. 295.
1865. *Nemacheilus triangularis*, Day, *Fish. Malabar*, p. 203, pl. xiv, fig. 1.
1868. *Nemachilus triangularis*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 352.
1872. *Nemacheilus triangularis*, Day, *Journ. As. Soc. Bengal* XLI, p. 194.
1878. *Nemacheilus triangularis*, Day, *Fish. India*, p. 619, pl. cliii, fig. 10.
1889. *Nemachilus triangularis*, Day, *Faun. Brit. Ind.* Fish. I, p. 234.
1909. *Nemachilus triangularis*, Jenkins, *Rec. Ind. Mus.* III, p. 289.
1929. *Nemachilus triangularis*, Pillay, *Journ. Bombay Nat. Hist. Soc.* XXXIII, p. 710.
1936. *Nemachilus triangularis*, John, *Journ. Bombay Nat. Hist. Soc.* XXXVIII, p. 710.

6 specimens, 45 to 73 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940, and April 1941.

4 specimens, 42 to 49 mm. in length. Manimala R., near Kangirappally, Central Travancore. C. C. John, 26.iii.1940.

6 specimens, 38 to 56 mm. in length. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.

1 specimen, 52 mm. long. Kulathupuzha, a tributary of Kallada R., Central Travancore. C. C. John, 14.ii.1940.

8 specimens, 42 to 64 mm. in length. Kallar stream at the foot of Ponmudi Hills, Western Ghats, South Travancore. S. Jones, April 1939.

Day described *Nemachilus triangularis* from two specimens collected at Mundikyum, Travancore. The type-specimens are now preserved in the collection of the British Museum and, according to Day, the longer of the two is 2·1 inches in total length. There appears to be considerable inconsistency in Day's earlier and later accounts of the species regarding the proportions of the various parts of the body to the total length and, moreover, Day's illustration of the fish, as has already been pointed out by Günther, is not satisfactory. In view of this, we give below a complete description of the species and figures from fresh specimens.

D.2/8 ; A.2/5 ; P.11 ; V.8.

Nemachilus triangularis is a pretty loach with a very characteristic colouration ; it is almost subcylindrical with the head and anterior

part of body slightly depressed. The head is conical and bluntly pointed anteriorly; its length is contained from 4·09 to 5·32 times in the standard length and from 5·13 to 7·11 times in the total length. The height of the head is contained from 1·45 to 1·88 times and its width from 1·28 to 1·55 times in its length. The eyes are of moderate size, are situated almost in the middle of the length of the head, and are not visible from below; the diameter of the eye is contained from 3·60 to 5·00 times in the length of the head, from 1·33 to 2·14 times in the length of the snout and from 0·80 to 1·57 times in the interorbital width. In the males there is a small, obtuse projection of the preorbital below the anterior corner of the eye. The nostrils are situated considerably nearer to the anterior border of the eye than to the tip of the snout; they are separated by a prominent flap. There are six moderately long barbels. The lips are thick, fimbriated and continuous at the angles of the mouth; the lower lip is interrupted in the middle. The inter-maxillaries form a beak-shaped, median projection, which, when the mouth is closed, lies in front of the lower jaw.

The depth of the body is contained from 6·28 to 9·17 times in the total length and from 5·06 to 7·70 times in the standard length. The caudal peduncle is well formed and is generally somewhat higher than long. The body is covered with small distinct scales and the lateral line is fairly extensive and generally complete.

The dorsal fin originates slightly in advance of the pelvics and its commencement is almost equidistant from the tip of the snout and the base of the caudal fin. Its margin is straight and oblique, except at the anterior end where it is rounded. The pectoral is generally somewhat shorter than the head, but may be equal to it or even slightly longer; it is broadly pointed in the middle and is separated from the pelvics by a distance equal to a third of its length. The pelvics are distinctly pointed in the middle and bear a fleshy appendage in the axil; they do not extend as far as the anal opening. The caudal fin is deeply bifurcate.

The colour pattern varies considerably with age. In a young specimen, 35 mm. in total length, the ground colour is pale-olivaceous and there are about 7 dark bands descending from above to the sides; they are angularly directed backwards and some of the anterior ones are united by narrow longitudinal streaks. Most of the bands are edged with madder brown, and rounded yellow spots are present in the angular parts of some of the anterior bands. There are four bands on the head, one on the snout, one below the eye and two behind it in the opercular region. The dorsal fin is provided with two bands and there are indications of two bands on the caudal. The anal and the pelvic fins are also provided with one band each. There is a black blotch at the base of the caudal.

Day[1] described the colouration of a specimen, 52·5 mm. in total length, as: "Yellowish-banded, each band being edged with black; seven along the body, which pass backwards towards the lateral line, and consequently are disposed in a V-shaped manner; one band passes over the operculum, a second through the eye and a third from the

[1] Day, F., *Proc. Zool. Soc. London*, p. 295 (1865).

orbit to the angle of the mouth. Dorsal with three irregular rows of black spots. Pectoral. ventral and anal unspotted, but darkest at their margins. Three black bands on the caudal, which has also a black base."

In a specimen, 72 mm. in total length, the colour pattern is still further modified. The ground colour of the head and the body is grayish and the pale bands on the body are broken up. There are seven bands, the anterior five are directed backwards, while the last two are vertical and are conspicuously edged with madder brown. There are a number of yellowish patches of different sizes and patterns above the lateral line. Five yellowish bands are present on the head and the colouration of the fins is similar to that described by Day.

Distribution.—Travancore. The specimens figured here were collected by the late Dr. N. Annandale at Courtallum, Travancore.

Measurements in millimetres.

	Pampadampara		Kallai Stream.			Achenkovil R.			Kulathupuzha.	Manimala R.		
Total length ..	55·0	70·5	42·0	57·0	67·5	38·5	53·2	56·5	51·5	42·5	48·0	49·2
Length of caudal ..	8·8	12·0	9·0	11·0	15·0	7·8	11·5	11·0	11·2	8·5	9·5	10·5
Length of head .	9·0	11·0	7·0	9·0	11·5	7·5	10·0	10·0	9·0	7·8	8·5	8·0
Height of head ..	5·5	7·0	4·0	5·5	7·0	4·0	5·5	6·0	5·5	4·5	5·0	5·3
Width of head ..	6·5	8·0	5·0	7·0	8·0	5·0	7·0	7·0	6·5	5·5	5·5	5·8
Depth of body ..	6·0	8·0	5·0	7·0	9·0	5·0	7·5	9·0	6·5	5·8	6·0	6·0
Diameter of eye ..	2·0	2·5	1·4	2·5	2·5	1·8	2·2	2·5	2·0	2·0	2·2	2·2
Length of snout ..	3·5	4·2	3·0	3·5	4·5	2·4	4·0	4·0	3·5	3·2	3·5	3·2
Interorbital distance	2·5	3·8	2·2	2·5	3·0	2·0	2·5	2·0	2·5	2·0	2·0	2·0
Length of dorsal ..	8·5	10·0	5·8	9·0	9·5	5·8	8·0	9·0	7·8	7·2	7·5	7·5
Length of pectoral	8·5	11·2	6·5	9·0	12·0	7·0	9·0	9·0	8·0	7·0	9·0	8·0
Length of ventral	7·8	9·2	6·0	8·5	10·0	5·8	7·0	8·5	7·5	5·5	7·5	6·2
Length of anal ..	7·0	9·2	5·0	7·0	8·5	5·0	7·0	7·0	6·0	5·8	7·0	6·2
Length of caudal peduncle.	5·0	8·0	4·0	5·8	5·8	3·5	5·0	5·5	4·0	4·0	4·0	4·5
Least height of caudal peduncle.	5·0	7·0	4·5	6·5	8·0	4·0	6·5	6·0	5·0	5·0	5·0	5·2

Callichrous bimaculatus (Bloch).

1936. *Callichrous bimaculatus*, Hora, *Rec. Ind. Mus.* XXXVIII, pp. 356-361.

2 specimens, 144 and 149 mm. in length. Near the source of Kallada R., 4 miles east of Thenmalai, Central Travancore. C. C. John, 9.ii. 1940.

1 specimen, 162 mm. long. Kulathupuzha, a tributary of Kallada R., Central Travancore. C. C. John, 14.ii.1940.

Recently one of us (Hora, *loc. cit.*) discussed the specific limits of *Callichrous bimaculatus*, and referred to the great range of variation exhibited by the species. In the specimens under report, the colouration varies considerably; one of the specimens is very dark all over, while the others are much lighter.

Batasio travancoria Hora & Law.

1941. *Batasio travancoria*, Hora and Law, *Rec. Ind. Mus.* XLIII, pp. 40-42, pl. ii, figs. 7-9, text-fig. 3.

1 specimen, 95 mm. long. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.

1 specimen, 85 mm. long. Near the source of Kallada R., 4 miles east of Thenmalai, Central Thravancorei. C. C. John, 9.ii.1940.

2 specimens, 78 and 105 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. C. C. John, 14.ii.1940.

1 specimen, 75 mm. long. Chittar Stream at Palode, South Travancore. C. C. John, 10.ii.1940.

Batasio travancoria was recently described by us and remarks were made on the remarkable discontinuous distribution of the genus. It is known so far from the central and southern parts of Travancore.

Mystus cavasius (Ham.).

1877. *Macrones cavasius*, Day, *Fish. India*, p. 447, pl. c, fig. 1.

1 specimen, 103 mm. long. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.

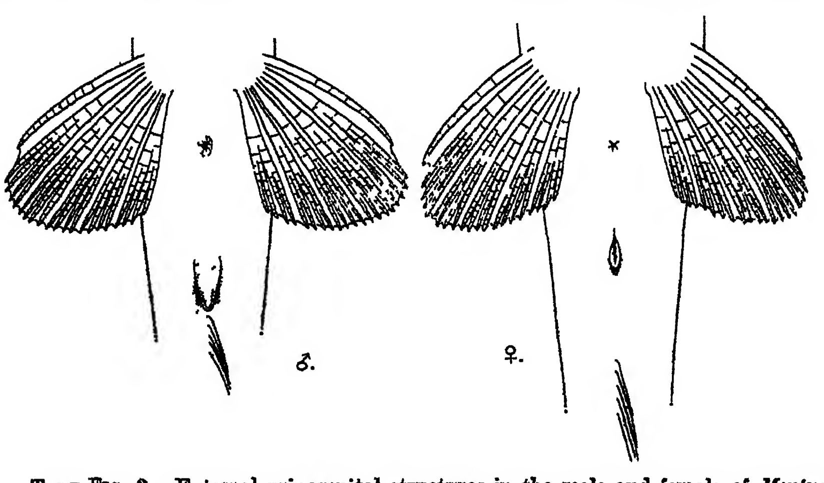
Mystus cavasius is widely distributed in the fresh waters of India and Burma. The specimen under report is a male with a well-developed urinogenital papilla; the free portion of the papilla being almost as long as the diameter of the eye. The testes are lobulated as in *M. malabaricus* (*vide infra*, p. 255).

Mystus malabaricus (Jerdon).

1877. *Macrones malabaricus*, Day, *Fish. India*, p. 450, pl. ci, fig. 2.
1936. *Macrones malabaricus*, John, *Journ. Bombay Nat. Hist. Soc.* XXXVIII, p. 709.

2 specimens, 89 and 111 mm. in length. A tributary of Manimala R., Erumeli, Central Travancore. C. C. John, 20.ii.1940.
6 specimens, 95 to 119 mm. in length. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.
1 specimen, 117 mm. long. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.
3 specimens, 99 to 118 mm. in length. Near the source of Kallada R., 4 miles east of Thenmalai, Central Travancore. C. C. John, 9.ii.1940.
3 specimens, 91 to 113 mm. in length. Chittar stream at Palode, South Travancore. C. C. John, 10.ii.1940.

In Dr. C. C. John's collection there are 15 male specimens from 5 localities, as listed above, which we refer to *Mystus malabaricus* (Jerdon).



TEXT-FIG. 3.—External urinogenital structures in the male and female of *Mystus malabaricus* (Jerdon). Male: × 2; Female: × 2½.

The males are provided with a urinogenital papilla, the size of which depends upon the sexual maturity of the individual irrespective of its

length. In immature specimens the testes are ribbon-like structures but become greatly enlarged and highly lobulated in adult males. The urinogenital duct opens at the extremity of the papilla. In the females the urinogenital opening is a slit-like aperture bordered by thickened lips. On account of these secondary sexual characters, the males and females can be distinguished readily. The anal opening is situated at a considerable distance in front of the urinogenital opening.

The presence of a urinogenital papilla is a fairly common occurrence among Siluroid fishes. Mukerji [1] recorded it in the case of *Glyptosternum reticulatum* McClelland. Day (*loc. cit.*, pp. 449, 450) referred to the presence of an anal papilla (=urinogenital papilla) in the case of two species of *Macrones* described and figured by him, *viz.*, *M. keletius* (Cuv. & Val.) and *M. armatus* Day. From among the specimens referred by Day to *M. malabaricus*, two are now preserved in the collection of Indian Museum; one (No. 721) is a male with a well developed papilla and the second is a female (No. 504). The former is the original of his figure in the *Fishes of India* and it seems that the presence of the papilla was overlooked. *M. malabaricus* differs from *M. keletius* and *M. armatus* by its smooth head and other characters of minor importance.

Recently Mookerjee, Mazumdar and Das Gupta[2] described similar urinogenital structures in *Mystus gulio* (Ham.), but used for them anthropomorphic terms and by implication assumed for them copulatory functions without giving reasons for their views. We found similar organs in all the species of *Gagata* and *Batasio* studied by us[3].

M. malabaricus is known from the Malabar Coast, Wynaad Hills and the hill ranges of Travancore.

Glyptothorax madraspatanus (Day).

1938. *Glyptothorax madraspatanus*, Hora, *Rec. Ind. Mus.* XL, p. 370.

1 specimen, 101 mm. long. Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940.

2 specimens, 67 and 110 mm. in length. Streams within a radius of 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, April 1941.

1 specimen, 173 mm. long. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.

In his key to the Indian species of the genus *Glyptothorax*, Hora [4] included *G. madraspatanus* in the group in which the ventral surface of the outer rays of the paired fins is not plaited. In the larger specimen under report, the skin on the ventral surface of the pectoral spine and that of the two outer rays of the pelvic fins form an adhesive pad of longitudinal grooves and ridges similar to those of the thoracic adhesive apparatus. It seems probable that this character, which is directly correlated with the rapidity of the current, is of little taxonomic value.

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[1] Mukerji, D. D., *Mem. Conn. Acad.* X, art. xviii, p. 329 (1936).

[2] Mookerjee, H. K., Mazumdar, S. R. and Das Gupta, B., *Ind. Journ. Vet. Sci. Animal Husb.* X, p. 295 (1940).

[3] Hora, S. L. and Law, N. C., *Rec. Ind. Mus.* XLIII, pp. 9-42 (1941).

[4] Hora, S. L., *Rec. Ind. Mus.* XXV, p. 12 (1923).

The lower lobe of the caudal fin of the larger specimen is abnormal; it is rounded instead of being pointed and has a Y-shaped whitish area in its distal portion.

Xenentodon cancila (Ham.).

1877. *Belone cancila*, Day, *Fish. India*, p. 511, pl. cxviii, fig. 5.

1 specimen, 222 mm. long. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.

Xenentodon cancila is widely distributed in the fresh waters of India and on account of its characteristic beak can be readily distinguished from other kinds of fish.

Ophicephalus gachua Ham.

1876. *Ophiocephalus gachua*, Day, *Fish. India*, p. 367.

5 specimens, 82 to 123 mm. in length. Streams within a radius of about 5 miles round Pampadampara, Western Ghats, North Travancore. S. Jones, 12.iv.1940 and April 1941.
1 specimen, 18 mm. long. Manimala R., near Kangirappally, Central Travancore. C. C. John, 26.iii.1940.
6 specimens, 36 to 51 mm. in length. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.
1 specimen, 47 mm. long. Kulathupuzha, a tributary of Kallada R., Central Travancore. (Collected from a pond-like accumulation of water surrounded by big boulders.) C. C. John, 14.ii.1940.

Ophicephalus gachua is represented in the collection by several young and half-grown specimens. This species is widely distributed through out the Oriental Region.

Mastacembelus armatus (Lacép.).

1876. *Mastacembelus armatus*, Day, *Fish. India*, p. 340, pl. lxxiii, fig. 2.

1 specimen, 225 mm. long. Pool at the foot of the largest fall of Peruntenaruvi, a tributary of Pamba R., at Edakadathy, Central Travancore. C. C. John, 11.ii.1940.
2 specimens, 64 and 257 mm. in length. Achenkovil R., 7 miles south-east of Konni, Central Travancore. C. C. John, 17.ii.1940.

Mastacembelus armatus is a widely distributed Indian fish; its range extends as far as China. As has already been noted by Day and other workers, the colouration of the species varies considerably with growth, and very young specimens[1] of about 2 to 3 inches in length look quite different from the adult.

[1] Hora, S. L. and Mukerji D. D., *Rec. Ind. Mus* XXXVIII, p. 145 (1936).

EXPLANATION OF PLATE IX.

THE FRESHWATER FISH OF TRAVANCORE.

Barbus (Puntius) curmuca (Hamilton).

FIG. 1.—Lateral view of a specimen showing the black-tipped caudal and tubercles on the side of the head : $\times \frac{7}{8}$.

Nemachilus guentheri Day.

FIG. 2.—Lateral view of a female specimen from Dhoni forest, S. Malabar : $\times$ *ca.* $2\frac{1}{4}$.

FIG. 3.—Ventral surface of head and anterior part of body of same : $\times$ *ca.* $2\frac{1}{4}$.

FIG. 4.—Lateral view of a male specimen from Nierolay stream, Nilgiri Hills : $\times$ *ca.* 2.

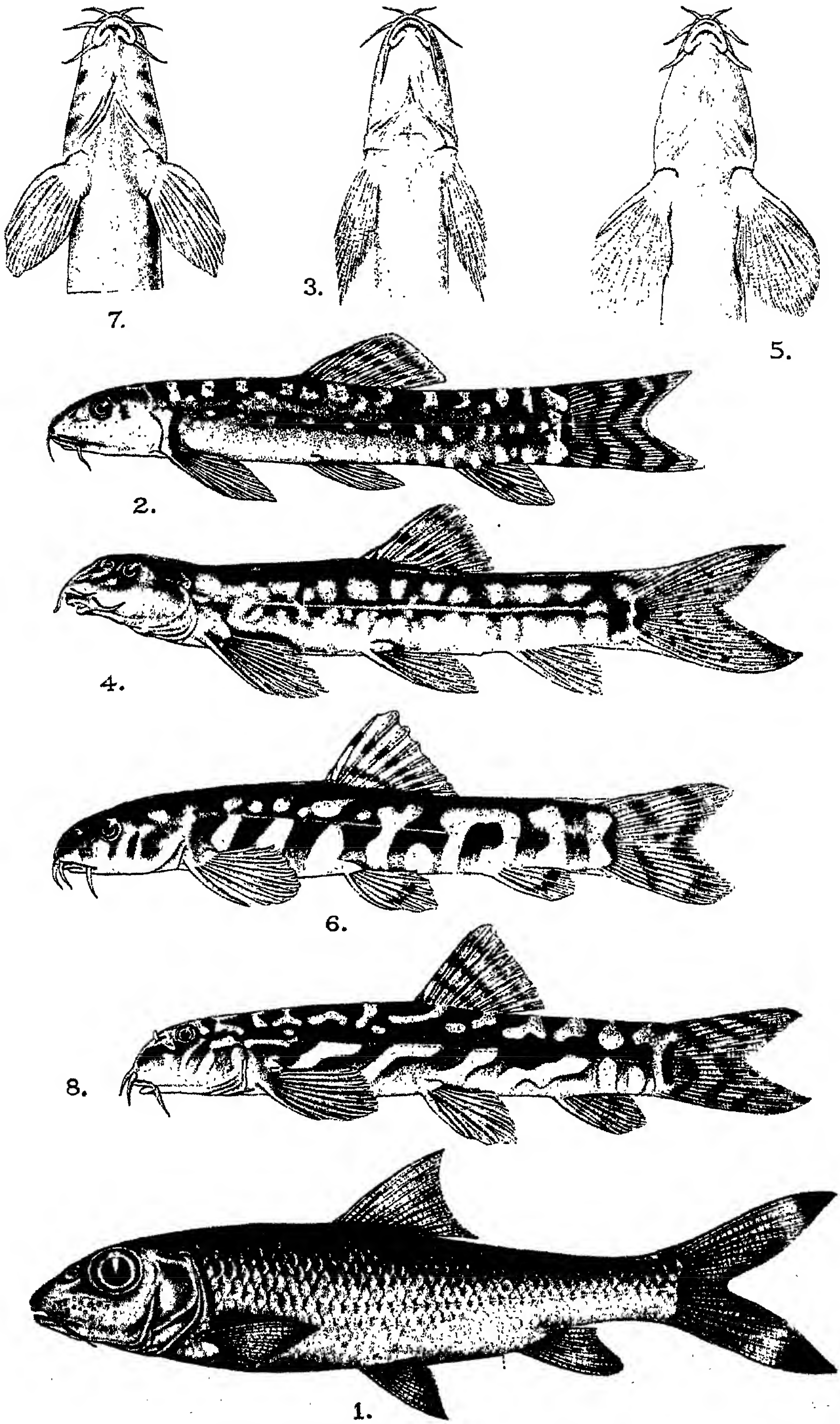
FIG. 5.—Ventral surface of head and anterior part of body of same : $\times$ *ca.* 2.

Nemachilus triangularis Day.

FIG. 6.—Lateral view of a juvenile specimen from Courtallum, Travancore : $\times$ *ca.* 3.

FIG. 7.—Ventral surface of head and anterior part of body of same : $\times$ *ca.* 3.

FIG. 8.—Lateral view of an adult specimen from Courtallum, Travancore, showing characteristic colouration of the species : $\times$ *ca.* $1\frac{2}{3}$.



B. N. Bagchi, del.

Freshwater Fish of Travancore.

TWO NEW SPECIES OF *OBEREA* FROM MADRAS (COLEOPTERA: CERAMBYCIDAE).

By J. C. M. GARDNER, *Forest Research Institute, Dehra Dun, U. P.*

Oberea artocarpi, sp. nov.

Ochraceous, except eyes, antennae, distal two-thirds of elytra and of wings and distal segment of abdomen (above and below) which are black. Pubescence very short uniformly corresponding in colour with the derm; there are a few longer hairs on head, pronotum and base of elytra. Body elongate.

Head and pronotum with rather coarse but shallow and not very distinct punctures: front in male a little wider than an eye (as seen in frontal view), distinctly wider in female; lower lobe of eye slightly wider than high, separated from mandible by about one-third its own height. Antennae reaching to about the elytral apex, the scape very finely rugulose, the third segment slightly longer than fourth. Prothorax wider than long, very slightly constricted anteriorly and posteriorly. Elytra a little wider than prothorax and slightly attenuated in the middle region, with two feeble costae behind the shoulder which do not reach the apex, the disc depressed; punctures mostly serially arranged, rather coarse basally, absent at apex; apex of elytron somewhat narrowed, truncate and slightly concave, the outer angle with a rather stronger angulation, the inner with a small point. Posterior femora reaching a little beyond second abdominal segment. Last sternite of female with a fine median line, of male with a shallow longitudinal depression. Length 12 mm. to 15 mm. Elytra about five times as long as prothorax.

Holotype (male) and four paratypes reared from green twigs of *Artocarpus integrifolia* sent to Dehra Dun from Palghat, Madras. Emergences from 31st March, 1941 to 4th April, 1941.

The new species has much in common with *O. clara* Pasc. (=*O. armata* Gah.) but has no median process on the first abdominal sternite and the colour is quite different.

Oberea mangalorensis, sp. nov.

Head, prothorax and underside (except last abdominal sternum) and legs fulvous; last abdominal segment black except a narrow space at base; antennae black; elytra fulvous on about the basal third, infuscated beyond that. Body form elongate.

Head closely and rather coarsely punctured on frons and above; frontal area higher than wide in male, wider in female; lower lobe of eye about as high as wide, reaching to near mandible. Antennae extending a little beyond elytra in male; third segment longer than fourth. Prothorax parallel sided, slightly longer than wide in male, about as long as wide in female; distinctly and rather closely punctured. Elytra slender, somewhat narrowed in middle region, serially punctate; the apices concave-truncate, the outer angle rather bluntly produced.

Posterior femora reaching to about middle of second abdominal segment. Abdomen with some larger punctures beneath. Last sternum of male with wide depression. Length 11 mm. to 14 mm.

Madras: South Mangalore, four specimens on foliage (J. C. M. Gardner). Holotype (female), allotype (male) and one paratype in Forest Research Institute: one paratype in Zoological Survey of India, Calcutta.

This species resembles *posticata* Gahan structurally but is distinguished by the black posterior segment of the abdomen and the posteriorly infuscated elytra.

MGIPC—M—III-8-23—21-6-41—370.

CYCLOPOIDES NOUVEAUX DU CONTINENT INDO-IRANIEN. II.

Par KNUT LINDBERG

Mesocyclops (Thermocyclops) mahéensis, sp. nov.

Description.—Longueur de la femelle adulte de 922 à 1017 μ (6 animaux mesurés); largeur environ 280 μ. Abdomen élancé, à segment génital allongé et peu élargi dans sa partie proximale. Bord postérieur du quatrième segment abdominal muni sur la moitié interne de la face ventrale d'un groupe de 5 à 6 épines extrêmement petites

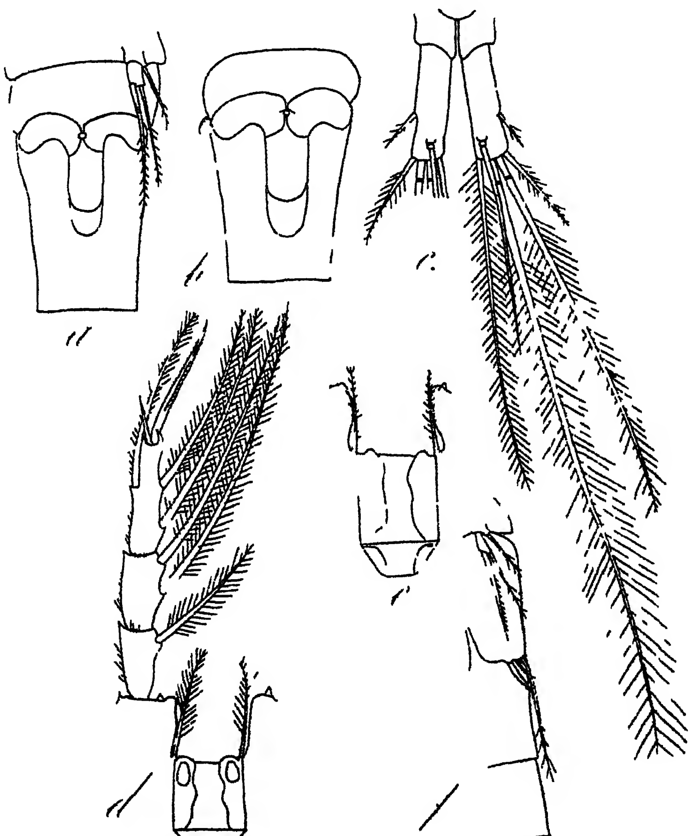


FIG. 1.—*Mesocyclops* (*Thermocyclops*) *mahéensis*, sp. nov.

a. ♀ Segment génital et P5; *b.* ♀ Segment génital, autre aspect; *c.* ♀ Furca, face dorsale; *d.* ♀ Endopodite de P4 et lamelle basale; *e.* ♀ Lamelle basale de P4, autre aspect; *f.* ♂ P5 et P6.

difficiles à distinguer. Furca à branches divergentes de 3·39 à 3·90 fois aussi longues que larges. Soie dorsale sans cils, très longue, mais

inférieure en longueur à celle de la soie apicale interne de la furca (moyennes respectives de 6 individus 135 et 181 μ). Pennation de la soie apicale médiane interne hétéronyme, les cils étant espacés sur la partie terminale mais très serrés et plus longs ailleurs. Première antenne à 17 articles ; lorsqu'elle est rabattue elle atteint le plus souvent le milieu du troisième segment thoracique : chez un animal elle atteignait le milieu du quatrième segment thoracique. Article terminal de l'endopodite de P4 plus de 3 fois aussi long que large. Son épine apicale interne dépasse en longueur celle de l'article et elle est environ 2·35 fois aussi longue que l'épine apicale externe. Lamelle basale de la quatrième paire de pattes à éminences latérales arrondies, dépourvues d'épines visibles aux grossissements ordinaires et faisant une très faible saillie au-dessus du rebord libre. Cinquième patte à deuxième article portant une épine interne barbelée, dont la longueur ne surpasse que de peu celle de la soie apicale. Réceptacle séminal à bras latéraux bien recourbés et à concavité proximale très profonde ; sa partie verticale apparaît bien moins allongée qu' elle ne l'est chez la majorité des *Thermocyclops*. Ovisacs petits, renfermant de 6 à 9 gros oeufs.

Mâle. Longueur 637 μ. L'unique spécimen examiné avait les branches de la furca parallèles, de 3·78 fois aussi longues que larges. Sa soie dorsale dépassait en longueur celle de la soie apicale interne. La sixième patte rudimentaire était formée d'une forte épine interne, d'une mince soie médiane plus courte et d'une longue soie externe ciliée, qui atteignait le tiers proximal du troisième segment abdominal.

Habitat.—Un bassin cimenté d'une mosquée à Mahé, côte de Malabar (Inde française) : récolté au mois de décembre.

Remarques.- L'espèce présente se distingue surtout par sa longue soie dorsale de la furca : sa lamelle basale de P4 à petites éminences, et par la structure du segment génital et du réceptacle séminal.

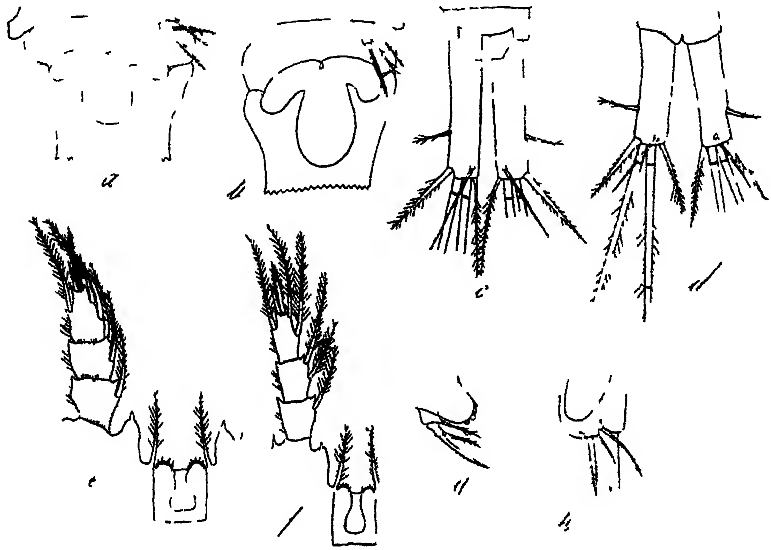
Pour autant qu'il me soit connu la seule forme avec laquelle on puisse la comparer est l'espèce africaine *M.* (*Th.*) *emini* (Mrazek). Elle s'en différencie par sa soie dorsale de la furca plus courte que la soie apicale interne, par la longueur plus considérable de l'épine apicale externe de l'article 3 de l'enp. 4 par rapport à celle de l'épine apicale interne et par cette dernière dépassant en longueur celle de l'article.

Mesocyclops (Thermocyclops) tinctus Lindberg.

Espèce décrite en 1936 d'après des spécimens jeunes et mal conservés, provenant de la partie désertique de l'Est du plateau Iranien. En 1940 j'ai trouvé dans plusieurs endroits du Sud-Ouest de l'Iran une forme qui, bien que de dimensions plus fortes, est manifestement identique à celle présentée sous le nom de *M.* (*Th.*) *tinctus*. Comme les figures et la description originales laissent à désirer une rédescription de cette espèce singulière et très remarquable est nécessaire.

Description.—Forme robuste. Longueur de la femelle ovigère (sans soies apicales) de 920 à 1254 μ ; largeur de 304 à 418 μ. Les bords postérieurs des trois premiers segments thoraciques apparaissent indistinctement découpés sur les parties latérales : au lieu de découpure les

ailes latérales du cinquième segment thoracique et surtout celles du quatrième offrent l'aspect d'être garnies d'excroissances verruqueuses de dimensions inégales. Cinquième segment thoracique surpassant en largeur celle du segment génital. Celui-ci, en général plus large que



— *Mesocyclops (Thermocyclops) tinctus* Lindberg

a. — Segment génital et P5 (Djam) : *b.* Segment génital et P5, autre aspect (Djam) : *c.* — Furca, face dorsale (Béhbéhan) ; *d.* Furca, face ventrale (Djam) : *e.* — Endopodite de P4 et lamelle basale (Béhbéhan) : *f.* — Endopodite de P4 et lamelle basale, autre aspect (Djam) : *g.* Aile latérale cinquième segment thoracique et P5 (Djam) : *h.* ♂ P6 (Béhbéhan).

long se rétrécit assez notablement du côté distal. Bords postérieurs des trois premiers segments abdominaux découpés en denteluro. Celui du quatrième segment abdominal porte sur la moitié interne de la face ventrale un groupe de 5 à 8 petites épines. Furca à branches divergentes ou parallèles. Des 12 femelles adultes examinées elles étaient bien divergentes chez 6, légèrement divergentes chez 2 : les 4 animaux restants avaient les branches de la furca parallèles. Leur rebord interne est glabre. Elles sont de 3·42 à 4·75 fois aussi longues que larges. Rapport moyen longueur : largeur, chez 12 spécimens 4·08 : 1. Soie latérale externe insérée à peu près vers l'union du tiers distal avec les deux tiers proximaux, mais elle peut se trouver à l'union du quart distal avec les trois quarts proximaux chez animaux à furca très allongée. Soie dorsale dépourvue de cils, le plus souvent égale ou un peu inférieure en longueur à celle de la soie apicale externe. Chez deux échantillons elle surpassait celle-ci légèrement. Soie apicale interne plus longue que la soie apicale externe. Rapport moyen, soie apicale interne. : soie apicale externe, chez 12 individus 1·30 : 1. Pennation des soies apicales médianes paraît homonyme. Première antenne à 17 articles, rabattue elle atteint le milieu ou le bord postérieur du deuxième segment thoracique. Article terminal de l'endopodite de la

quatrième paire de pattes toujours moins de deux fois aussi long que large, le rapport variant de 1·40 : 1 à 1·95 : 1, avec une moyenne de 1·58 : 1, chez 11 spécimens étudiés. Epine apicale interne considérablement plus longue que l'article (rapport moyen 1·22 : 1) et surpassant de beaucoup la longueur de l'épine apicale externe (rapport moyen, épine apicale interne : épine apicale externe, 1·77 : 1). Lamelle basale de la quatrième paire de pattes pourvue de chaque côté d'une éminence arrondie, peu élevée, garnie de quelques petites épines. Cinquième patte à deuxième article trapu ; épine interne de cet article dépassant légèrement en longueur celle de la soie apicale. La configuration du réceptacle séminal se voit sur les figures. Ovisacs de dimensions très variables, contenant le plus souvent de 6 à 12 oeufs. Chez un animal d'un étang de la région de Béhbéhan ils dépassaient l'extrémité de la furca et renfermaient 26 et 28 oeufs. Coloration rouge intense.

Mâle. Longueur de 836 à 955 μ (cinq animaux examinés). Bords postérieurs des trois premiers segments abdominaux découpés en petites dents ; celui du quatrième segment abdominal semble porter une rangée continue de petites épines sur la face ventrale, au lieu d'en être muni d'un petit groupe comme chez la femelle. Branches de la furca parallèles ou légèrement divergentes, de 3·77 à 4·55 fois aussi longues que larges. Soie dorsale considérablement plus longue que chez la femelle. Article terminal de l'enp. 4 et ses appendices ressemblant à ceux de la femelle. Sixième patte rudimentaire formée d'une épine interne assez forte, le plus souvent dépassant un peu le bord postérieur du deuxième segment abdominal, d'une soie médiane beaucoup plus courte et d'une soie externe qui est l'appendice le plus long.

Habitats.—Béhbéhan, petit étang dans les montagnes, à 24 kilomètres au sud-est de la ville et mare de rivière à environ 20 kilomètres de la ville dans la même direction : Djam, citerne naturelle dans un rocher à environ 12 kilomètres au nord du village ; Makkou, citerne cimentée couverte ; Tang-Gaz, rivière ; Tang-Qil, mare de rivière. Saghand (environ 100 kilomètres au nord-est de Yezd), bassin, octobre 1935.

Remarques.—Le *M.* (*Th.*) *tinctus* est remarquable surtout par l'ornementation des bords latéraux du quatrième et du cinquième segments thoraciques, par son segment génital le plus souvent plus large que long, son article terminal de l'endopodite de P4 court et élargi, moins que deux fois aussi long que large, et par la configuration assez distinctive de la cinquième patte.

M. (Th.) mahéensis, sp. nov.

Longueur μ.	Furca.	Soie dorsale.	Soies apicales.	Art. 3 enp. 4 Long. : larg.	Art. 3 enp. 4 Ep. ap. int. : ép. ap. ext.	Ep. ap. int. : long. art. 3.	P6 : Epine : soie méd. : soie ext.
♀ 969	(46 + 32) : 23 = 3·39 : 1	125	63 : 242 : 392 : 167	..	..	..	..
♀ 969	(47 + 30) : 22 = 3·50 : 1	133	68 : 225 : 342 : 187	..	..	..	.
♀ 940	(46 + 32) : 20 = 3·90 : 1	143	67 : 233 : 381 : 178	62 : 18 = 3·44 : 1	67 : 28 = 2·39 : 1	67 : 62 = 1·08 : 1	..
♀ 922	(43 + 30) : 19 = 3·84 : 1	142	62 : 222 : 347 : 187	57 : 18 = 3·17 : 1	62 : 25 = 2·48 : 1	62 : 57 = 1·09 : 1	..
♀ 1017	(48 + 30) : 20 = 3·90 : 1	135	70 : 234 : 384 : 185	58 : 19 = 3·05 : 1	62 : 27 = 2·29 : 1	62 : 58 = 1·07 : 1	..
♀ 931	(50 + 27) : 22 = 3·50 : 1	138	63 : 225 : 342 : 184	62 : 20 = 3·10 : 1	65 : 28 = 2·32 : 1	65 : 62 = 1·05 : 1	..
♂ 637	(30 + 23) : 14 = 3·78 : 1	108	38 : 153 : 229 : 100	45 : 15 = 3 : 1	47 : 22 = 2·14 : 1	47 : 45 = 1·04 : 1	23 : 17 : 83

M. (*Th.*) *tinctus* Lindberg. ♀.

Localité.	Longueur μ.	Furca.	Soie dorsale.	Soies apicales.	Art. 3 enp. 4 Long. : larg.	Art. 3. enp. 4 Ep. ap. int. : ép. ap. ext.	Ep. ap. int. : long. art. 3.	P6 Epine : soie méd. : soie ext.
Béhbéhan	1187	(80+50) : 32=4·06 : 1	75	77 : 277 : 369 : 110	43 : 30=1·43 : 1	57 : 32=1·78 : 1	57 : 43=1·32 : 1	.
Petit étang	1206	(92+50) : 35=4·06 : 1	92	92 : 303 : 420 : 120	53 : 32=1·65 : 1	68 : 36=1·89 : 1	68 : 53=1·28 : 1	
	988	(70+38) : 25=4·32 : 1	77	83 : 292 : 371 : 97	43 : 22=1·95 : 1	52 : 30=1·73 : 1	52 : 43=1·21 : 1	
Béhbéhan	1216	(88+45) : 33=4·03 : 1	95	90 : 310 : 460 : 130	50 : 30=1·67 : 1	62 : 33=1·89 : 1	62 : 50=1·24 : 1	.
Mare de rivière	1092	(91+42) : 28=4·75 : 1	70	80 : 260 : 364 : 102	45 : 32=1·40 : 1	60 : 33=1·82 : 1	60 : 45=1·33 : 1	..
	1245	(91+42) : 32=4·16 : 1	70	83 : 304 : 427 : 103	47 : 32=1·47 : 1	55 : 35=1·57 : 1	55 : 47=1·17 : 1	.
Djam	950	(67+38) : 25=4·20 : 1	67	68 : 237 : 370 : 87	.	..	.	.
	911	(71+37) : 27=4 : 1	70	65 : 222 : 339 : 83	42 : 26=1·62 : 1	52 : 30=1·73 : 1	52 : 42=1·24 : 1	..
	920	(83+30) : 26=4·35 : 1	58	67 : 250 : 344 : 93	45 : 26=1·73 : 1	50 : 30=1·67 : 1	50 : 45=1·11 : 1	
Makkou	988	(70+33) : 26=3·96 : 1	67	78 : 242 : 350 : 92	40 : 27=1·48 : 1	50 : 27=1·85 : 1	50 : 40=1·25 : 1	.
Tang-Gaz	1254	(80+33) : 33=3·42 : 1	75	75 : 292 : 439 : 108	43 : 28=1·53 : 1	50 : 27=1·85 : 1	50 : 43=1·16 : 1	..
Tang-Qil	1007	(73+40) : 29=3·80 : 1	73	80 : 264 : 381 : 100	45 : 28=1·60 : 1	50 : 29=1·72 : 1	50 : 45=1·11 : 1	.

M. (*Th.*) *tinctus* Lindberg, ♂.

Localité.	Longueur μ.	Furca.	Soie dorsale.	Soies apicales.	Art. 3 enp. 4 Long. : larg.	Art. 3. enp. 4 Ep. ap. int. : ép. ap. ext.	Ep. ap. int. : long. art. 3.	P6 Epine : soie méd. : soie ext.
Béhbéhan	884	(67+33) : 22=4·55 : 1	100	62 : 275 : 400 : 87	47 : 42=1·12 : 1	55 : 33=1·67 : 1	55 : 47=1·17 : 1	58 : 30 : 67
Petit étang	..	..	..	.	.	..	..	..
Béhbéhan	955	(71+32) : 23=4·48 : 1	92	68 : 302 : 477 : 85	45 : 28=1·60 : 1	62 : 43=1·44 : 1	62 : 45=1·38 : 1	53 : 30 : 67
Mare de rivière	..	..	..	..	..	.	.	52 : 33 : 77
Djam	836	..	..	..	43 : 22=1·95 : 1	50 : 33=1·52 : 1	50 : 43=1·16 : 1	47 : 20 : 70
Tang-Qil	846	(53+30) : 22=3·77 : 1	80	58 : 230 : 371 : 63	40 : 25=1·60 : 1	53 : 37=1·43 : 1	53 : 40=1·32 : 1	50 : 33 : 75

A BIBLIOGRAPHY OF THE MELOLONTHINE GENUS *ECTINOHOPLIA* (SCARABAEIDAE).

By L. B. Boyer, *San Francisco, California, U. S. A.*

The fascinating asiatic melolonthine genus *Ectinohoplia* has been studied exclusively by Europeans, except for scattered observations written by Nipponese. Consequently, the literature concerning *Ectinohoplia* is confined to European and Japanese entomological journals.

Perhaps a bibliography of that literature, published in an Indian journal, will serve a two-fold purpose: first, that of presenting an adequate bibliology, for none exists; second, that of inciting interest in one of the most colorful and attractive scarabaeid genera, among entomologists who know the beetles in their indigenous habitat.

Since the publication of Junk's Catalogue of the Coleoptera, much information has accrued. Some of the insects which had been considered to belong to another group have been consigned to this genus: three of the beetles[1] which were described as *Ectinohoplia* have been found to be representatives of the *Hoplia*. Several new species have been named and a complete revision of the genus has appeared.

Policy.

According to the present author's interpretation of the International Rules of Zoological Nomenclature, the term "variety" commands no nomenclatorial respect. As expressed elsewhere,[2] he feels that the usage of varieties is both unnecessary and an impediment to Linnean systematics. However, in a bibliography it is exigent to include all literature of the subject chosen, within certain limits. In compliance with these opinions, the following rule is adhered to in this bibliology: Synonymy of varieties before they have been promoted to species or subspecies will be ignored.

This bibliography includes references only to descriptions and revisions. Travel notes are not included.

Explanatory Note.

Brenske, in 1895, considered *variegata* de Borre and *variolosa* Waterhouse to be the same species. In 1903, Reitter synonymized *variegata* and *variolosa* with *obducta* Motschulsky. However, Arrow judged *variegata* to be identical with *paivae* Wollaston; he confirmed Reitter's consideration of *variolosa*. Arrow's adjudication is here held to be correct.

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[1] *E. mus* and *E. hüttenbacheri* Nonfried and *E. latesurata* Fairmaire.

[2] Boyer, L. B., *Microentomology* V, part 1, pp. 1, 2 (1940).

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[1] References marked with an asterisk are not included in Arrow's revision.

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STUDIES ON CESTODE PARASITES OF FISHES. II. THE NERVOUS SYSTEM OF *TYLOCEPHALUM DIERAMA* SHIPLEY AND HORNELL.[1]

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CONTENTS.

INTRODUCTION.

The present work is the outcome of some fundamental problems which arose when I had to describe a Monozootic Cestode whose features appeared to be different from those of Gyrocotylidae. Fuhrmann's account of the Cestoda in Kükenthal's Handbuch der Zoologie (1930) does not mention the nervous system in the definition of Cestodaria. The definition takes into account only the disposition of the generative organs and the character of the larva. It is a well-known fact that in the case of many fish parasites the proglottides are capable of living freely in the alimentary tract after having become detached from the proglottid chain. The problem thus reduces itself to the question: How can one distinguish a free living proglottid from a monozootic Cestode? I have seen in several cases immature free living proglottides and so, if the larva is not available, the differentiation of a free living proglottid from a monozootic Cestode becomes virtually impossible. It appeared to me that the only definite evidence that one could rely on for differentiation is the nervous system. Theoretically therefore a monozootic Cestode should have a closed nervous system consisting of a brain and a system of nerve cords while in the free living proglottid the brain should be absent. It was because I found a closed nervous system in *Biporophyllaeus* (Subramaniam 1939) that I described it as

[1] An abstract of this paper was read before the 28th Session of the Indian Science Congress held at Benares in January 1941.

belonging to a new order of Cestodaria. And it was on the same ground that I suggested that the Caryophyllaeidae should be included among the Cestodaria.

I have to state, however, that descriptive accounts of the nervous system of representative members of the various families of Cestode parasites of fishes are not available in the few papers published on the subject. Very little is known about the arrangement of the nerves in the proglottides and nothing about the changes in the nervous system following the separation of a proglottid from the chain. It has also to be mentioned here that very few of the older workers used any of the typical neurological technique so that even to-day the study of the nervous system of cestodes remains the step-child of Helminthologists.

I thought that investigations of the nervous system of Cestodes of fishes belonging to the various families would offer a solution to the difficulties mentioned above. The choice of material for an investigation of this sort is not, however, at the command of the investigator. Nothing is known about the extent, the rate and the time of incidence of the various fish parasites. It will be obvious, therefore, that one has to take his chance with the material available. Often it is likely that the investigator may not obtain another lot of material during the year. A systematic neurological investigation of representative members of the various families is therefore not possible. The only possible alternative is an investigation of such specimens belonging to different families as may be available, and arrive at some definite conclusions after a survey of the whole field when a sufficient number of representatives of the different families have been investigated. The following is a preliminary attempt in the direction outlined above.

MATERIAL AND METHODS.

In the present paper is recorded the investigations carried out on specimens of *Tylocephalum dierama* Shipley and Hornell, collected in July 1939 from *Rhynchobatus djeddensis*. About 250 specimens were available, out of which 50 were fixed in ammonia alcohol and chloral hydrate alcohol, 30 in Golgi's osmo-bichromate mixture, and the rest in 5 per cent formalin. Part of the material fixed in chloral hydrate alcohol and ammonia alcohol was treated with pyridine before transfer to silver nitrate. Golgi's rapid method and Cajal's methods were thorough failures. Material fixed in 5 per cent formalin was then treated according to the Bielchowsky method. For about 6 months the attempts to impregnate the fibrils and nerve cords were without success. It was then discovered that treatment with pyridine was essential. Finally, by manipulating the time in pyridine, silver bath and ammoniacal silver bath, some very good impregnations were obtained. It was found that in light impregnations the nerve cords were brownish while the nerve fibres proceeding in various directions from the cord were yellow. The vitelline glands being argentophile, obscured, in deeper impregnations, the finer details of the origin and direction of the fibrils leaving the nerve cords. Naturally, therefore, all the descriptions are based on examination of preparations impregnated in varying grades of intensity. Almost all workers on the nervous system

of tapeworms describe ganglia and commissures especially at the posterior end of the mature segments. No ganglionic thickenings were observed in the nerve cords of *Tylocephalum*, but the commissure at the posterior end of the segments was prominent. Since the ganglionic cells were indistinct in these preparations, a re-investigation with the Bielchowsky technique was found essential. Material silvered without previous treatment with pyridine was, in the majority of cases, useless. But, in a few, the ganglionic cells were impregnated. In such preparations the peripheral fibrils were unstained. There was also the question of the nature of arrangement of the muscles in the segments. Southwell (1925) in his Monograph on the Tetraphyllidea figures a row of longitudinal muscles in the parenchyma. The first few series of Bielchowsky preparations suggested that what Southwell took for muscle bundles were nerve cords. Therefore material preserved in 5 per cent formalin was fixed in Susa and Bouin Duboscq, sections were cut, and part of the Susa material was stained with Mallory's triple stain. An examination of the Mallory-stained sections revealed a subcuticular muscle system composed of outer circular and inner longitudinal fibres. The bundles of fibres which stained positively with Bielchowsky were light violet while the muscle fibres were light red. In such Susa-Mallory preparations, the fibrils proceeding to the various tissues, the circular commissures and the posterior plate commissure were light violet in colour.

The Bouin Duboscq and Susa material, when stained with iron haematoxylin, showed the subcuticular muscles blue, while the nerves were unstained and structureless in appearance. Counterstaining with eosin or orange G did not improve the appearance. When the Bielchowsky material was mordanted for 2-3 days in iron alum and stained in haematoxylin for 4-5 days the ganglionic cells could be seen in the nerve cords. In such slides the ganglionic cells themselves are deep black while the fibres to the various organs are brownish yellow. In some cases such preparations are found more suitable for photomicrography than the Bielchowsky preparations. The muscle fibres in these preparations are blue black and in those regions of the worms where the outer layers are slightly macerated, the longitudinal and circular fibres together give a lattice-work-like appearance (Pl. X, fig. 1). Thus in *Tylocephalum dierama* there is no medullary longitudinal or circular muscle layer.

The histological details were confirmed by Vom Rath preparations stained with iron haematoxylin by the long process. In spite of the large quantity of material available, the histology of the brain could not be investigated satisfactorily, probably due to the long treatment of the parasites with tap water. The worms occurred firmly attached to the folds of the spiral valve and they released their hold only after having been in tap water for 30-45 minutes. Attempts to remove them by force resulted in the proglottid chains snapping near the neck region. As repeated examinations for the past one year of the spiral valve of *Rhynchobatus* and other allied rays have failed to reveal any *Tylocephalum dierama*, a more detailed histological study of the brain has to wait till further material is available.

The Brain.

The brain lies in the middle of the myzorhynchus (Pl. X, figs. 2, 3). In well expanded specimens the myzorhynchus is egg shaped and the brain lying in it has the shape of an arc. This is but a plane view. If reconstructed from serial longitudinal and transverse sections it is seen to have the shape of a conical cap. The posterior half of the brain presents a vacuolated appearance in Bielchowsky and Vom Rath longitudinal sections. In Vom Rath slides each of these vacuoles presents the appearance of a nucleus (Pl. X, fig. 4. *nc.*). Some of these show distorted nucleoli while in others a tangled mass of chromophile threads may be seen. The cytoplasm covering these nuclei is thin and not very clear and small bundles of fibres could be seen running antero-posteriorly between the nuclei. Plate X, figure 3 shows the innumerable bundles proceeding from the brain fan-wise to the anterior edge of the myzorhynchus.

A transverse section of the brain shows that it is a plate-like structure. In Bielchowsky preparations (Pl. X, fig. 5) radiating fibres could be seen proceeding in a radial direction all round. Careful examination of the section under oil immersion shows innumerable very minute nuclei. These occur in rows. A Vom Rath transverse section gives a slightly better idea of the histology of the brain (Pl. X, figs. 6, 7, *nc.*). The nuclei appear to be of two types: (1) large ones as seen in longitudinal sections and (2) small ones arranged in a linear manner. These rows of nuclei separated from one another by small bundles of fibres are arranged in the shape of concentric arcs. Plate X figure 7 gives a very good idea of the arrangement. As in the case of the larger ganglion cells these minute nuclei have only a very thin cytoplasmic coat. A nucleolus is present in many of these nuclei. Nerves to suckers arise separately from the brain. From transverse and longitudinal sections it appears that the sucker is constituted by one layer of cells. The outer half of the cells in Bielchowsky iron haematoxylin preparations appears darkly stained. The basal half is unstained and nuclei occur about the middle of the clear half.

In silvered preparations the nerve proceeding from the brain is observed to touch the anterior inner border of the sucker. The base of the sucker has an investment of fibrils and from this meshwork fine fibres could be seen proceeding between the cells.

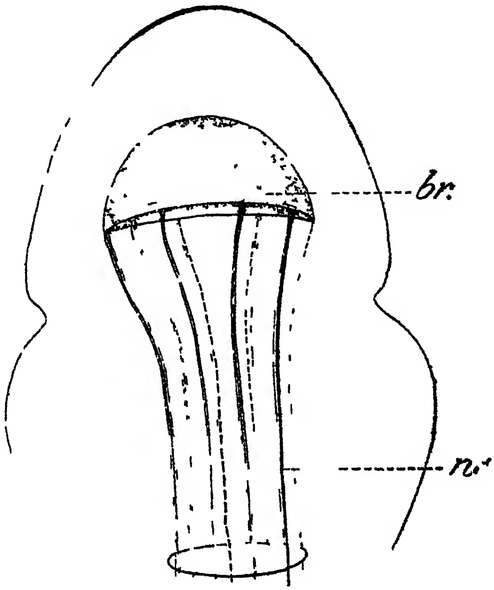
To sum up: It is observed that the brain is not constituted by a system of ganglia but is plate-like, the slight differences in shape depending on the degree of contraction of the head and myzorhynchus. The nerve cords take their origin from the posterior margin of the brain. Bundles of fibres proceed anteriorly and get distributed at the anterior edge of the myzorhynchus. There are large and small ganglion cells in the brain.

Nerves in the dilated portion of the Head and the Neck.

The number of nerves starting from the brain could not be definitely mentioned as the bundles lie close together and merge into one another near the brain In transverse sections (Pl. X, fig. 8) 8-14

bundles of nerves could be seen in the region of the sucker, each bundle being composed of 2 or more nerves. In some bundles it is possible to count the number of nerves constituting the bundle but in others they are so closely packed as to present the appearance of a single nerve.

In text-figure 1 is given a diagrammatic representation of the brain and the arrangement of the nerves in the dilated portion of the head.



TEXT FIG. 1.—A diagrammatic representation of the brain and the nerves in the neck region of *Tylocephalum dierama* Shipley & Hornell. *br.*, brain ; *n.*, nerve cords.

The neck region is very short and transverse sections show a variable number of nerves ranging from 32 to 42.

NERVES IN THE EARLY SEGMENTS.

The nerve cords in the early segments are oval in transverse sections and have a diameter varying from 8·3 μ to 18·3 μ along their longest axis which has a radial direction. In frontal and sagittal sections passing near the surface, where in a single section several nerve cords may be observed lying side by side, fine fibres are seen running from one cord to another (Pl. X, fig. 9) at irregular intervals presenting a ladder-like appearance. At the hind end of the early segments the commissure is virtually absent. But in segments about 1 mm. from the posterior border of the head, the commissure could be observed as a few fibres.

In Bielchowsky iron haematoxylin material the neurones are deeply stained. A differentiation of such cells into nucleus and cytoplasm is however impossible. Either the whole neurone is yellow or it is stained blue black. The ganglionic cells appear to be of three types. Most of them are bipolar but what look like unipolar and multipolar ones are also met with (Pl. X, fig. 10. *mg.*).

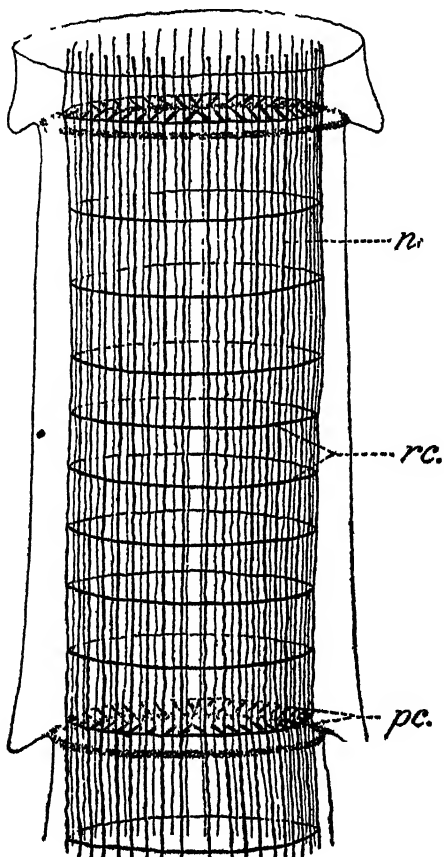
Compared to the maturing proglottides (Pl. XI, fig. 1), the neurones in the early segments seem to be more closely packed together. Though in general there is no marked concentration of ganglionic cells in any particular region of the nerve cord in a segment, occasionally cells are concentrated in particular regions, as for instance, near the posterior margin of the segments. Here unipolar and multipolar cells are found to be present. These cell aggregations do not, however, touch the posterior wall of the segment. Rarely aggregations are seen in the nerve cord about the middle of the segment.

In some regions of the nerve cords unipolar ganglion cells dominate. They are thinner than the bipolar ones, but longer. The nerve cord has a yellowish appearance in Bielchowsky iron haematoxylin preparations due to the large number of brownish nerve fibrils. Some of the ganglionic cells have a curved contour, one of the ends of the cell body touching the lateral margin of the nerve (Pl. XI, fig. 2, *nc.*). From this end the fibre could be traced to the tissue or organ innervated. The fibre from the portion of cell body parallel to the nerve cord gets mingled with the other fibres. The fibres of some of the bipolar ganglion cells which are disposed lengthwise in the nerve cord could be seen leaving the latter at some distance. Binding cells are absent and therefore the nerve cords are loose in structure. Scattered ganglion cells are often found outside the nerve cord running parallel to the nerves, between them and the cuticle. The longest diameter of the nerves in early segments varies from 8 μ to 18 μ, the body of the bipolar neurones measure from 7 μ to 15 μ in length and 1·66 μ to 3·3 μ in width and the multipolar neurones vary from 5-17 μ in length and 2-4 μ in width. In the early segments the main nerve cords do not give rise to nerve branches. Innervation is by nerve fibrils which leave the cords at irregular intervals. In the very early segments succeeding the neck region few of the organs are differentiated and one does not see the complicated tangle of nerve fibrils observed in maturing segments.

It is surprising to find on examination of several series of sections that the number of nerves is always even, if not constant and varies from 32 to 42. The usual number, however, is 38. It will be observed that while dealing with the nerves of the neck and the very early segments the same variation in number was mentioned. What strikes one in a transverse section is the constant occurrence of commissures connecting the nerve cords (Pl. XI, figs. 3, 4). This has actually the appearance of a circle of tangled fibres, the nerves forming knots in this circle. The most prominent commissure is at the hind end of each segment near the septum (Pl. XI. fig. 5).

The ring commissure appears to be formed by fibres from one nerve cord passing on to those on either side of it. The number and complexity of these ring commissures increase with the maturity of the segments, and in a mature segment itself the circular commissures are more abundant in the posterior half. The plate commissure at the posterior end of the segment is formed by a meshwork of fibrils. The meshwork is loose in the middle segments and compact in the later and mature ones. The lateral margins are strongly salient or imbricated and overlap the anterior end of the succeeding segment. Therefore the nerve cords occur at different depths from the cuticular margin

in different regions of the same proglottid. At the anterior end of each proglottid there appear to be very few layers of subcuticular cells between the nerve cord and the cuticle, and passing backward they have a deeper disposition especially near the posterior margin. Near the imbricated edge one bundle of fibres leaves each of the nerve cords to the cuticle at the level of the posterior plate commissure (Pl. XI, fig. 6). Nerve cells are not found in this branch which appears to correspond to the marginal nerve described by Tower (1900). This nerve does not proceed even half way up the segment but its fibres separate fan-wise and come into contact with the sense cells lying midway between the nerve cords and the cuticle in the subcuticular layer. Due to the salient posterior margin the septa between the segments are not exactly transverse but are semi-circular. In sections therefore we see only portions of the plate commissure (Pl. XI, fig. 5, *pc.*).



TEXT-FIG. 2.—A diagrammatic representation of the nerves and commissures in a mature segment of *Tylocephalum dierama* Shipley & Hornell. *n.*, nerve cords; *pc.*, plate commissure; *rc.*, ring commissure.

NERVES IN THE MATURE SEGMENTS.

As the generative organs mature and the segments increase in size and thickness, the nerve cords, which had their longest axes disposed

in a radial direction in transverse sections, become thinner, lose their oval shape, and assume an irregular appearance. Even the thickness of a nerve cord varies from region to region in the same segment.

Binding cells are absent and most of the ganglion cells are bipolar. Multipolar cells are present but unipolar ones are scarce. The measurements of these cells fairly agree in their range with those in the early segments. Here also very large ganglion cells, 17 μ by 3 μ, are occasionally met with. In Bielchowsky iron haematoxylin preparations the ganglionic cells stain blue black, and in many longitudinal sections single ganglionic cells lying outside but parallel to the nerve cords, may be observed.

From Vom Rath preparations it appears that the nuclei of multipolar ganglion cells are almost round and have a diameter of 2·0 μ. The round nuclei of bipolar cells measure 0·83 μ to 1·66 μ and the oblong nuclei of the large bipolar cells 6·6 μ by 4·2 μ.

In Bielchowsky preparations the nuclei of the neurones are dark brown while the cytoplasm is yellow. The nucleus in bipolar cells is slightly oval, and the biggest measures 2·0 μ. The biggest unipolar ganglion cells is 10 μ long and 1·7 μ wide. The average size of nuclei in multipolar cells is 2·5 μ.

Text figure 2 is a diagrammatic representation of the arrangement of the nerves and commissures in a mature segment.

INNERVATION OF THE VARIOUS ORGANS.

It will be seen from the foregoing account that the nerves form a cylinder enclosing the various organs in the medulla. Separate nerves to groups of organs or tissues were not observed and each organ is innervated by nerve fibrils having their origin in different nerve cords lying in the same sector containing the organ. In order to give a clear idea of the mode of innervation I shall describe first the distribution of nerve fibrils to the ovary.

(*a*) *The Ovary.*—The ovary is a globular organ, $\frac{1}{6}$ to $\frac{1}{3}$ as long as the mature segment, occupying the hinder end of the segment. It is really composed of two lobes which lie touching each other. The bilobed appearance, however, is very marked in the centre of the organ where the two lobes are caved in to lodge the shell gland. The organ is composed of radiating acini which differ in size among themselves. Owing probably to the removal of fat in the oocytes, during fixation and dehydration, these acini show only irregular scattered nuclei inside, which, with bits of cytoplasm sticking to them, represent the oocytes.

Plate XI, figure 7 is a longitudinal section showing the fibres leaving one of the nerve cords. A number of separate fibres leave the nerve cord near the junction between two acini and running along the junction either terminate in the acinus itself or proceed to the tissues and organs in the interior. As the nerve fibrils seem to take a wavy course and as there is a mingling of the fibres having their origin in different nerves or different portions of the same nerve, very few of the fibres proceeding to the inner regions could be traced along their entire course. Though no ganglionic cells occur in the posterior plate commissure,

yet in longitudinal sections nerve fibrils could be seen leaving the commissure and running between two acini.

Plate XI, figure 5 is a transverse section from a Bielchowsky preparation. It shows the fibres leaving the various nerve cords and their course in the ovary. In the dorso-ventral space between the two lobes of the ovary large numbers of fibres may be seen proceeding towards the middle. These fibres start from nerves lying near that region. The fibres from the nerves not directly above the space between the two halves of the ovary take a curved course and are joined by fibrils from the nerves lying just above it

(*b*) *The Testicular Vesicles.*—The above description makes it easy to understand the mode of innervation of the other organs, as it is identical in all organs.

The segments of the middle region of the worms are packed with testicular vesicles: the vitelline glands and ovary have not, however, begun to develop. Most of the testicular vesicles show fully developed sperms. Plate XI, figure 8 from a Bielchowsky preparation shows how irregular is the course of the nerve fibres from the nerve cords. The testicular vesicles are matted over with nerves fibrils, which, are shown by transverse sections, to arise from all the nerve cords.

Complex networks of fibrils occur also in regions where vitelline glands and ovary develop later. In segments where the vitelline glands and ovary are well developed the testicular vesicles are pushed into the middle owing to the development of the vitelline glands at the two sides. Some of these testicular vesicles extrude their contents and then degenerate, and in a mature segment one of the testicular vesicles lying near the cirrus pouch is considerably bigger than the others. Transverse sections show that these vesicles lying in the medulla are innervated by fibrils originating from the nerve cords lying in the same are as the vesicle. In many cases it was observed that the bundle proceeding to the testicular vesicles was composed of many fibres though coming from different cords.

(*c*) *The Vitelline Glands.* After the completion of the spermatogenesis in most of the testicular vesicles, the vitelline glands begin to develop. In the mature segments they are well developed and massive and extend in some cases along the sides of the ovary to the few acini which occur in almost all segments behind the ovary.

Plate XI, figure 9 shows the innervation of the vitelline glands. It is a longitudinal section and shows the fibrils leaving a single nerve cord, while Plate XI, figure 1 shows how fibrils from a number of nerve cords take part in the innervation of an acinus.

Sense Organs.

In deep impregnations many of the fibrils leaving the nerve ring or nerve cords seem to end near nuclei lying midway between the nerve cords and the cuticle. These nuclei appear to be those of the sense cell as shown previously by Blochmann (1895). Under an oil immersion, fibrils from these nuclei could be seen taking a wavy course and ending in knob-like swellings on the inner edge of the cuticle. Irregular precipitation of silver occurs on the cuticle in deep impregnations and in

most cases these end knobs are indistinct. In light impregnations they could be seen as triangular or egg-shaped structures yellowish brown in colour. Due to the wavy course of the fibrils from the sense cells, the whole fibril is not in the same plane and hence more than one photograph is required to show the fibril connections of the sense cell to the nerve ring on the one hand and the cuticle on the other. Plate XI, figure 10 shows this relation. The cytological structure of the sense cells is not very clear. Fibres going directly to the cuticle without any contact with sense cells have also been observed.

DISCUSSION.

In order to compare the nervous system of *Tylocephalum dierama* described above, a knowledge of the systematic position of the worm is essential. *Tylocephalum* possesses a typical Cyclophyllidean head, but the genitalia resemble in arrangement those of the Tetraphyllidea. This mixture of the Tetraphyllidean and Cyclophyllidean characters has led to its being included in either of the above orders. Meggitt (1924) and Fuhrmann (1930) included *Tylocephalum* in the order Tetraphyllidea, and separated the Cyclophyllidea from all the other orders on account of the compact and unpaired nature of the vitelline glands. Southwell (1925) on the other hand included it among the Cyclophyllidea arguing that if the globular portion of the head in *Tylocephalum* has arisen as a result of the fusion of the bothridia one might also assume that a similar process has occurred in the whole of the Cyclophyllidea. The various species of the genus itself show variation. In *Tylocephalum dierama* the vitelline glands occur as two massive organs whose acini extend on either side up to the anterior end of the ovary, and in many cases even to the posterior end of the segment. But in *T. uarnak* the vitelline glands are single and very small and placed behind the ovary. From the above it would appear that *Tylocephalum* may possibly be a connecting link between Tetraphyllidea and Cyclophyllidea.

Cohn (1900)[1] as a result of his researches concludes that the primitive form of the nervous system which must have governed the common ancestors of Cestodes should have been an irregular network traversing unbrokenly the entire body of the Cestodes. He states that in all the Cestodes studied by him the two main longitudinal stems have already been differentiated and therefore considers the nervous system of *Ligula* as the simplest of the extant types. *Ligula* and *Schistocephalus* have two main longitudinal stems and a much larger number of longitudinal nerves than any other Cestode. The main reason for the belief that they occupy the lowest position is that all the longitudinal nerves—the two main ones excepted—are exactly similar and without any secondary differentiation. Cohn argues therefore that the meagre adaptation of these animals to intestinal parasitism is the cause for the absence of any differentiated development in these animals, and this seems to be substantiated by the insignificant development of the sucker grooves and the resulting simplicity of the scolex innervation.

[1] My thanks are due to Mr. N. T. Mathew, *M.Sc.*, for help in translation of the paper.

It will be seen that the nervous system of *Tylocephalum* is more primitive than that of *Ligula* and *Schistocephalus*. The brain is a cap-shaped plate from which arise 32-42 nerves. As in *Ligula* and *Schistocephalus* there is an irregular meshwork of nerve fibrils at the very anterior end of the proglottid chain, though further behind the meshes have differentiated themselves into ring commissures. But Cohn's explanation that the primitive nature of the nervous system of *Ligula* and *Schistocephalus* is due to their meagre adaptation to intestinal parasitism does not hold good in the case of *Tylocephalum*. Development of suckers on the head is a distinct adaptation to parasitism, but why *Tylocephalum* has a simpler nervous system than *Ligula* is at present inexplicable. The question whether the nervous system of *Tylocephalum* is the simplest in the polyzootic Cestodes cannot also be answered until many more members of the different families of Cestodes are investigated. As simplicity of arrangement of the nervous system does not indicate poor adaptation in *Tylocephalum* it is likely that further exhaustive studies may alter entirely the present conceptions of the phylogenetic relationships among the various orders of Cestodes.

SUMMARY AND CONCLUSIONS.

The nervous system of *Tylocephalum dierama* is very simple in plan. The brain is not constituted by a system of ganglia but is plate like and the slight differences in shape observed in different examples are due to the various degrees of contraction of the head and myzorhynchus. Bundles of fibres proceed from the brain and get distributed at the anterior edge of the myzorhynchus. There are large and small ganglion cells in the brain. Thirty-two to forty two nerves, all of the same thickness, run through the length of the proglottid chain. A meshwork of nerve fibrils connecting the nerve cords is present at the extreme anterior end of the proglottid chain but further behind the meshes have differentiated themselves into ring commissures. The commissure at the posterior end of each proglottid is plate-like. The nervous system of *Ligula* and *Schistocephalus* is supposed to be the most primitive as the insignificant development of the sucker grooves in these animals indicates a poor adaptation to parasitism. These animals have two main lateral stems and a far larger number of longitudinal nerves than any other Cestode. In *Tylocephalum dierama* all the nerves are of the same size, and therefore it is assumed that its nervous system is more primitive than that of the two above mentioned animals. As simplicity of arrangement of the nervous system does not indicate poor adaptation in *Tylocephalum* as evidenced by the presence of suckers —it is likely that further exhaustive studies may alter entirely the present conceptions regarding the phylogenetic relationships among the various orders of Cestoda.

ACKNOWLEDGMENT.

I wish to express my grateful thanks to Professor R. Gopala Aiyar for his criticisms and encouragement.

EXPLANATIONS OF LETTERING IN PLATES.

Br., Brain; *cm.*, Circular muscles; *lm.*, Longitudinal muscles: *mg.*, Multipolar ganglion cells: *mn.*, Marginal nerve; *n.*, Nerve cord; *nc.*, Nerve cells; *nf.*, Nerve fibrils; *oa.*, An Acinus of the ovary; *pc.*, Plate commissure; *rc.*, Ring commissure: *sc.*, Sense cells; *tv.*, Testicular vesicles.

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EXPLANATION OF PLATE X.

FIG. 1. A longitudinal section showing the subcuticular circular and longitudinal muscles and the nerve cord. Bielchowsky. Iron Haematoxylin: × 636.

FIG. 2. A longitudinal section of the head showing the brain. Vom Rath. Iron Haematoxylin: × 195.

FIG. 3. A longitudinal section showing the brain and bundles of nerve fibrils to the tip of the myzorhynchus. Bielchowsky: × 195.

FIG. 4. A portion of the brain magnified to show the large ganglion cells. Vom Rath. Iron Haematoxylin: × 636.

FIG. 5. A transverse section showing the brain and the radiating nerve fibrils. Bielchowsky. × 288.

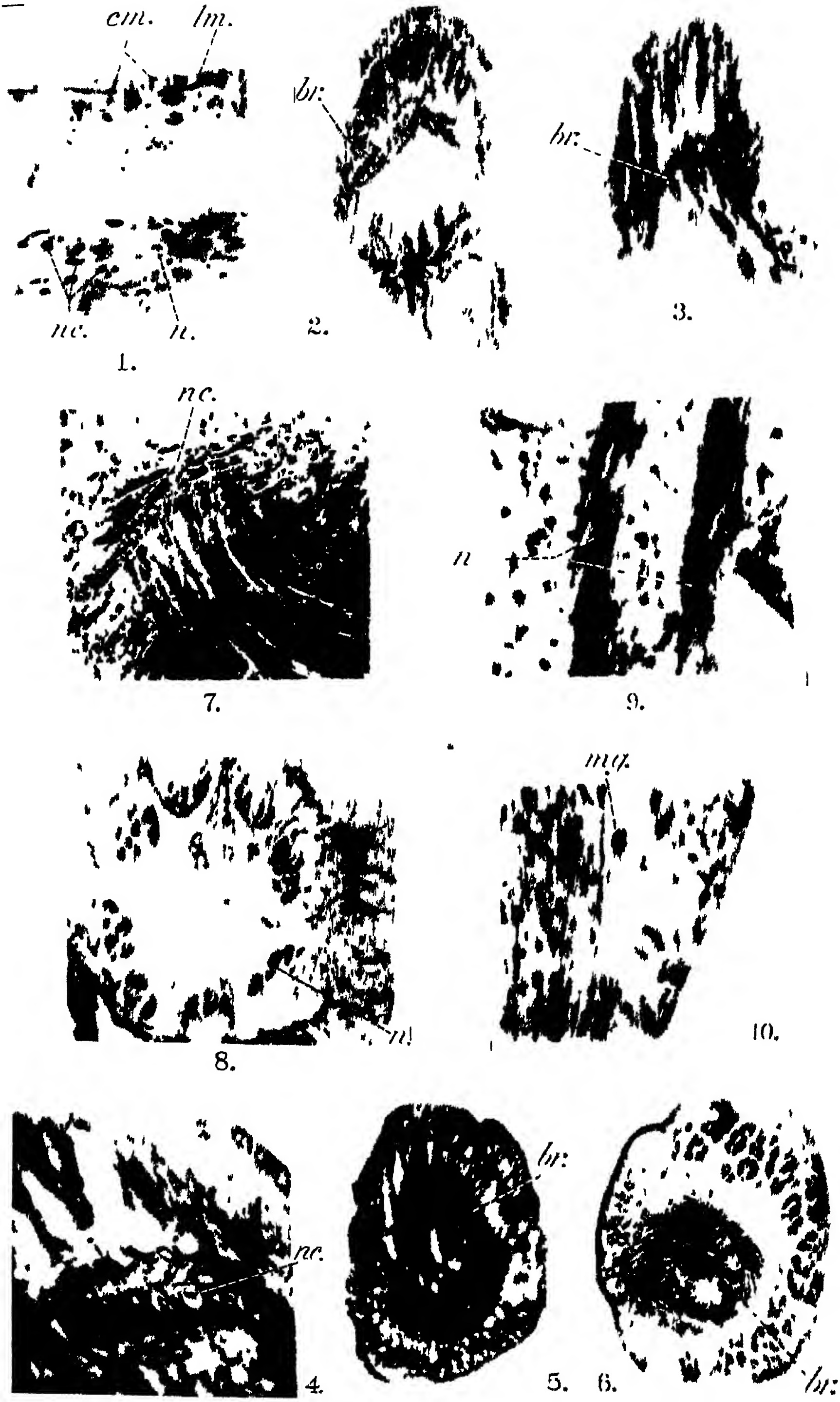
FIG. 6. A transverse section showing the arrangement of the small ganglion cells in the brain. Vom Rath. Iron Haematoxylin: × 195.

FIG. 7. A portion of the brain seen in Fig. 6. enlarged. Vom Rath. Iron Haematoxylin: × 636.

FIG. 8. A transverse section showing the arrangement of the nerves in the dilated portion of the head. Bielchowsky: × 195.

FIG. 9. A longitudinal section showing the ladder-like connections between two adjacent nerve cords in the early segments. Bielchoswky. Iron Haematoxylin: × 660.

FIG. 10. A longitudinal section showing multipolar and bipolar ganglion cells in the early segments. Bielchowsky. Iron Haematoxylin: × 636.



Nervous System of *Tylocephalum dierama*.

EXPLANATION OF PLATE XI

FIG. 1.—A longitudinal section showing the nerve cord in a mature segment. Bielchowsky. Iron Haematoxylin. ×636.

FIG. 2.—A longitudinal section showing nerve cells lying transversely in the nerve cord. Bielchowsky. Iron Haematoxylin. ×636.

FIG. 3.—A transverse section of the mature segment showing the nerve cords and the ring commissure. Bielchowsky. ×636.

FIG. 4.—A transverse section showing nerve fibrils proceeding from a nerve cord to innervate the vitelline glands and structures in the medulla. Bielchowsky. ×660.

FIG. 5.—A transverse section showing the plate commissure and the nerve fibrils innervating the acini of the ovary. Bielchowsky. ×195.

FIG. 6.—A longitudinal section showing the marginal nerve. Bielchowsky. ×660.

FIG. 7.—A longitudinal section showing the nerve fibrils leaving one of the nerve cords for the innervation of the acini of the ovary. Bielchowsky. ×636.

FIG. 8.—A longitudinal section showing the arrangement of nerve fibrils in a segment in the middle of the proglottid chain. Bielchowsky. ×180.

FIG. 9.—A longitudinal section of a mature proglottid showing the bundles of nerve fibrils leaving one of the nerve cords for the innervation of the vitelline glands and the testicular vesicles. Bielchowsky. ×219.

FIG. 10.—A portion of a transverse section of a mature segment showing sense cells and fibrils from sense cells terminating in the cuticle. Bielchowsky. ×660.

Nervous System of *Tylocephalum dierama*.

CATALOGUE OF BIRDS IN THE INDIAN MUSEUM, CALCUTTA.

I. COLUMBAE (PIGEONS AND DOVES).

By M. L. ROONWAL, *M.Sc., Ph.D. (Cantab.), Zoological Survey of India, Calcutta.*

CONTENTS.

I. FOREWORD.

The bird skins in the collection of the Museum of the Asiatic Society[1], which formed the nucleus of the Indian Museum collection of birds, were listed by Edward Blyth in his well known *Catalogue of the Birds in the Museum of the Asiatic Society of Bengal* in 1849. Subsequent to the foundation of the Indian Museum this bird collection grew enormously as a result of the disinterested but devoted labours of a number of distinguished ornithologists in the country; their names are given in the list published by Sclater in his account of the India Museum collection[2]. In addition, a number of skeletons of birds, a small collection of bird eggs, and a few nests, have been added to the collection from time to

[1] All collections in the Museum of the Asiatic Society of Bengal, Calcutta, were formally transferred to the authorities of the newly constituted Indian Museum about 1865, though the building of the Museum was not completed till 1875.

[2] Sclater, W. L., *Ibis* (6) IV, pp. 69-71 (1892).

time. On the foundation of the Zoological Survey of India in 1916, the bird collection, together with all other collections in the Natural History section, including Ethnology, were transferred to the Director, Zoological Survey of India, and have been under his charge since that date.

The large collection of bird skins, however, remained almost entirely uncatalogued, except for being serially entered in a number of accession registers as the skins were received and identified.

The only published catalogues of this collection are the following :—

(1) *A List of Birds' Eggs in the Indian Museum, Calcutta.* (Author not given) 1st edition : 1890. 2nd edition : 1891.

(2) *A List of Type-specimens in the Indian Museum Collection and a Brief History of the Collections as a whole*, by W. L. Sclater, *Ibis* (6) IV, pp. 69-71 (1892).

(3) *List of Birds in the Indian Museum*, by F. Finn[1] :

Part I (1901) —Families : Corvidae, Paradiseidae, Ptilonorhynchidae and Crateropodidae.

Part II (1905) —Families : Sittidae, Dicruridae, Certhiidae, Regulidae and Sylviidae.

The bird collection in the Indian Museum at present consists of nearly 27,000 registered and a few hundred unregistered skins. Outside workers are naturally handicapped in the study of the Indian birds owing to the absence of any information regarding the collections in the Indian Museum. This is particularly unfortunate, as the Indian Museum collection, in so far as the Indian birds are concerned, is probably only next to the collection in the British Museum both in regard to its size and importance. Unfortunately this state of affairs could not be remedied, as ever since Mr. Frank Finn's retirement from the Indian Museum staff in 1901 no suitably trained officer has been in charge of the Bird Collection. In 1939, Dr. M. L. Roonwal was appointed as a probationer to look after the collections of birds and mammals, and soon after his appointment, it was decided to make a start by preparing an up-to-date catalogue of the collection. The first part of this Catalogue - on Columbae or Pigeons and Doves, which Dr. Roonwal has prepared is now issued. Catalogues of the other orders will be prepared and published as and when ready.

The collection of birds in the Indian Museum is, as noted above, fairly large, but it is not fully representative of all the species found in India. Several species are either totally unrepresented, or only a few badly preserved skins are available. I take this opportunity of requesting workers all over the country to help us in filling up the lacunae in the collection of India's National Museum of Natural History. The desiderata in regard to Pigeons and Doves are listed on pp. 288, 289, but any specimens for increasing the collection and filling up the lacunae will be very gratefully received.

INDIAN MUSEUM,
Calcutta ;
16th June, 1941.

BAINI PRASHAD,
Director,
Zoological Survey of India.

[1] Only two parts of the list were published.

II. INTRODUCTION.

(a) CLASSIFICATION OF THE COLUMBAE

Owing to the structural uniformity of the Columbae, the classification of this order is not easy, and the various schemes of classification suggested have not found general acceptance. Salvadori (1893), after a study of the Pigeons and Doves of the world, introduced the following classification which is, so far, the best available. I have adopted this classification, with such changes in family and subfamily names as are indicated by alterations in generic nomenclature—the new family and subfamily names are given within brackets.

1) *Salvadori's classification.*

Ord. COLUMBAE.

- Subord. I. *COLUMBAE.*
  - Fam. (i) TRERONIDAE.
    - Subfam. 1. *TRERONINAE*
    - Subfam. 2. *PTILOPODINAE* (modern *PTILINOPINAE*)
    - Subfam. 3. *CARPOPHAGINAE* (modern *DUCULINAE*)
  - Fam. (ii) COLUMBIDAE.
    - Subfam. 1. *COLUMBINAE.*
    - Subfam. 2. *MACROPYGIINAE.*
    - Subfam. 3. *ECTOPISTINAE.*
  - Fam. (iii) PERISTERIDAE (modern CLARAVISIDAE).
    - Subfam. 1. *ZENAIDINAE.*
    - Subfam. 2. *TURTURINAE* (now merged into *COLUMBINAE*).
    - Subfam. 3. *GEOPELIINAE.*
    - Subfam. 4 *PERISTERINAE* (modern *CLARAVISINAE*).
    - Subfam. 5. *PHABINAE.*
    - Subfam. 6. *GEOTRYGONINAE*
    - Subfam. 7. *CALOENADINAE*
  - Fam. (iv) GOURIDAE.
  - Fam. (v) DIDUNCULIDAE.
- Subord. II *DIDI.* (Extinct)

The following new names have to be adopted for the reasons given below :—

Ptilopodinae, based on genus *Ptilopus* Strickland 1841 (not Schonherr 1826), is changed to Ptilinopinae, based on genus *Ptilinopus* Swainson 1825. which replaces *Ptilopus* Strickland. Carpophaginae, based on genus *Carpophaga* Selby 1835, is changed to Duculinae, based on genus *Ducula* Hodgson 1836, which includes *Carpophaga* Selby. Peristeridae and Peristerinae, based on genus *Peristera* Swainson 1827 (not Rafinesque 1815), are changed to Claravisidae and Claravisinae respectively, based on genus *Claravis* Oberholser 1899, which replaces *Peristera* Swainson. Turturinae, based on genus *Turtur* Selby 1835 (not Boddaert 1783) is given up being merged into Columbinae, as *Turtur* Selby. which was the sole genus in the subfamily Turturinae as used by Salvadori, is now merged into the genus *Streptopelia* Bonaparte 1855 belonging to the subfamily Columbinae[1]. Also see Peters 1937, for some changes in generic nomenclature.

The revised classification of the Suborder Columbae as employed in the present Catalogue is given below. Families and subfamilies

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[1] The modern genus *Turtur* Boddaert 1783 (=*Chalcopelia* Bonaparte 1855 of Salvadori) belongs to the subfamily Phabinae.

occurring within the Indian limits[1] are marked with a dagger (†), while all those represented in the Indian Museum collection are marked with an asterisk (*).

Subord. *COLUMBAE.*
- Fam. (i) *†TRERONIDAE.
  - Subfam. 1. *†*TRERONINAE*
  - Subfam. 2. *†*PTILINOPINAE*
  - Subfam. 3. *†*DUCULINAE.*
- Fam. (ii) *†COLUMBIDAE
  - Subfam. 1. *†*COLUMBINAE.*
  - Subfam. 2. *†*MACROPYGIINAE*
  - Subfam. 3. *ECTOPISTINAE*
- Fam. (iii) *†CLARAVISIDAE.
  - Subfam. 1. *ZENAIDINAE*
  - Subfam. 2. *†*GEOPELIINAE.*
  - Subfam. 3. *CLARAVISINAE.*
  - Subfam. 4. *†*PHABINAE*
  - Subfam. 5. **GEOTRYGONINAE*
  - Subfam. 6. †*CALOENADINAE.*
- Fam. (iv) GOURIDAE.
- Fam. (v) DIDUNCULIDAE.

(ii) *Other classifications.*

Peters (1937) has combined the Sand-grouse (Suborder Pterocletes) and the Pigeons and Doves (Suborder Columbae) into the Order Columbiiformes. The Suborder Columbae is further divided as follows:—

- Fam. (i) RAPHIDAE (= DIDI of Salvadori). Extinct.
- Fam. (ii) COLUMBIDAE.
  - Subfam. 1. *TRERONINAE* (= *TRERONIDAE* of Salvadori).
  - Subfam. 2. *COLUMBINAE* (= *COLUMBIDAE* + *PERISTERIDAE* of Salvadori).
  - Subfam. 3. *GOURINAE* (= *GOURIDAE* of Salvadori).
  - Subfam. 4. *DIDUNCULINAE.* (= *DIDUNCULIDAE* of Salvadori).

Peters's Treroninae and Columbinae are large, unwieldy subfamilies, which it is preferable to divide further according to Salvadori's subdivisions which appear to be both natural and practical.

Stuart Baker (1928, p. 179) had adopted the following grouping for the Indian species:

Ord. COLUMBAE.
- Fam. COLUMBIDAE.
  - Subfam. 1. *TRERONINAE.*
  - Subfam. 2. *GEOPELIINAE.*
  - Subfam. 3. *DUCULINAE.*
  - Subfam. 4. *CALOENADINAE.*
  - Subfam. 5. *PHABINAE.*
  - Subfam. 6. *COLUMBINAE.*

The comparative importance of the subfamilies is here either over- or under-emphasized as the classification does not take into account extra-Indian subfamilies.

(b) INDIAN SPECIES OF THE COLUMBAE.

The home of the Columbae (Pigeons and Doves, but excluding the Raphidae) is the Indo-Malayan Region where they are found in great abundance and variety; both these features, however, tail off in the Australian Region. The Palaearctic Region (Old World) is poor in Columbae, and the New World still poorer.

Of the 59 world genera and 841 species and subspecies (including 30 doubtfully distinct and 5 extinct forms) recognised by Peters (1937),

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[1] By the term "Indian limits" is meant the following area: The whole of India (politically so known, including Gilgit and the North-West Frontier Province in the north to Cape Comorin in the south, and from British Baluchistan and Indian Mekran in the west to Assam in the east); Burma south to Tenasserim; Ceylon; and the Andamans, the Nicobars and other islands in the Indian Ocean. These are the limits covered by the official *Fauna of British India, Birds,* 2nd ed., Vols. I-VIII (1922-30) by Stuart Baker.

there are represented within the Indian limits 10 genera and 59 species and subspecies—if *Dendrophassa bicincta praetermissa* (Rob. & Kl.) is regarded as distinct from *D. b. bicincta* (Jerd.), the number 59 would be raised to 60. If the genera and forms recognised by Stuart Baker (1928) are accepted, there occur within the Indian limits 18 genera and 62 species and subspecies. The reasons for this difference are given below; it may be added that Peters is in many cases supported by Ticehurst (1930) who has given reasons for not including certain forms as Indian.

Dendrophassa bicincta praetermissa (Rob. & Kl.).—This subspecies is admitted by Stuart Baker. Peters, however, does not separate it from the typical *bicincta*. I have tentatively accepted *praetermissa* (but *vide* pp. 301-304).

The following three subspecies are regarded by Stuart Baker as occurring within the Indian limits, but Peters does not include India within their range :- *Columba livia livia* Gm., *Streptopelia turtur turtur* (Linn.) and *Streptopelia senegalensis ermanni* (Bonap.).

Chalcophaps indica maxima Hartert.--This subspecies from the Andamans was first recognised in 1931, and is accepted by Peters. Stuart Baker (1928) included the Andaman birds under *C. i. indica* (Linn.).

For the Indian forms I have retained the 18 genera used by Stuart Baker, except *Sphenocercus* G. R. Gray 1840 which is replaced by the earlier *Sphenurus* Swainson 1837. Table 1 below gives a list of Stuart Baker's Indian genera and their equivalent under Peters's nomenclature.

Table 1.

Generic names of Indian Columbae as used by Stuart Baker (1928) and by Peters (1937).

Stuart Baker.	Peters.
1. *Crocopus* Bonaparte	Merged into *Treron* Vieillot.
2. *Dendrophassa* Gloger	
3. *Treron* Vieillot	
4. *Butreron* Bonaparte	*Butreron* Bonaparte.
5. *Sphenocercus* G. R. Gray (1840)	*Sphenurus* Swainson (1837).
6. *Ducula* Hodgson	Merged into *Ducula* Hodgson.
7. *Muscadivora* Selby	
8. *Myristicivora* Reichenbach	
9. *Caloenas* G. R. Gray	*Caloenas* G. R. Gray.
10. *Chalcophaps* Gould	*Chalcophaps* Gould.
11. *Columba* Linnaeus	Merged into *Columba* Linnaeus.
12. *Alsocomus* Blyth	
13. *Ianthoenas* Reichenbach	
14. *Dendrotreron* Hodgson	
15. *Streptopelia* Bonaparte	Merged into *Streptopelia* Bonaparte.
16. *Oenopopelia* Blanford	
17. *Macropygia* Swainson	*Macropygia* Swainson.
18. *Geopelia* Swainson	*Geopelia* Swainson.

The majority of the Indian Columbae regularly breed within the Indian limits. In a few cases, namely, *Dendrophassa pompadora chloroptera* (Blyth) and *Janthoenas palumboides* (Hume), although the birds most probably breed within the Indian limits, nothing is known of their nidification. *Columba leuconota gradaria* Hartert has as yet been known as breeding only in the region around Gyantse (southern Tibet); no breeding records of it are available within the Indian limits, but it is not unlikely that the bird might be breeding near the borders of Tibet and Yunnan. Similarly, *Geopelia striata striata* (Linnaeus) is so far known to breed in the Malay Peninsula and further south, but no breeding records are available within the Indian limits although the bird occurs in southern Tenasserim; it is not unlikely that a few breeding birds might be found in southern Tenasserim. Of *Streptopelia turtur arenicola* (Hartert) no authentic breeding record within the Indian limits is available. *Butreron capellei* (Temminck) is a straggler in Mergui from the Malay Peninsula, etc., and is not known to breed within the Indian limits. Finally, *Columba eversmanni* Bonaparte is only a winter visitor to India and is not known to breed within the Indian limits.

The greater number of the Indian Columbae are resident and non-migratory although several species do undergo local migrations. The following 10 species and subspecies are migratory (apart from local migrations), some strongly so, others comparatively slightly:—*Sphenurus sphenurus sphenurus* (Vigors), *Myristicivora bicolor* (Scopoli), *Columba leuconota leuconota* Vigors, *Columba leuconota gradaria* Hartert, *Columba eversmanni* Bonaparte, *Columba pulchricollis* Blyth, *Dendrotreron hodgsonii* (Vigors), *Streptopelia turtur arenicola* (Hartert), *Streptopelia orientalis orientalis* (Latham) and *Streptopelia orientalis meena* (Sykes).

(c) *General particulars regarding the Columbae skins in the Indian Museum.*

(i) *General.*

The Indian Museum collection of the Columbae consists of some 675 skins of which 520 are of forms occurring within the Indian limits; the remaining 155 are extra-Indian. All of these, with the exception of 20 skins of foreign Columbae which could not be identified, are included in the present Catalogue. They comprise 28 genera and some 96 species and subspecies. Of these latter, 54 species and subspecies are Indian, 6 (or 7) of a known total of 59 (or 60) being not represented in the collection; and the remainder are foreign.

The skins in the Indian Museum are mostly rather old and represent most of the collection of the Asiatic Society of Bengal which formed the nucleus of the Indian Museum collection. Most of the skins and types listed by Blyth (1849) are available, although some have now become brittle and their colour faded. The donors who largely contributed towards the building up of the Museum's collection of Columbae are mentioned below:—

E. Blyth (1849, *Catal. Birds Mus. Asiat. Soc. Bengal*); T. C. Jerdon (1848, a few skins from South India); V. Ball (1868, several skins from

Bihar); Dr. J. Anderson (some skins from Upper Burma and Western Yunnan collected during the two British Expeditions to Yunnan during 1868 and 1875 and described in 1879 in *Zool. Results Two Yunnan Exped., 1868, 1875*; also some skins from Tenasserim and the Mergui Archipelago, 1882); Capt. (later Major and afterwards Sir O. B.) St. John (1870, some skins from southern Iran); Dr. G. Henderson (several skins collected in the Punjab, Kashmir and Eastern Turkestan during Forsyth's First Yarkand Mission of 1870, and described in Henderson & Hume's *Lahore to Yarkand*, 1873): W. T. Blanford (an excellent series of skins from Eritrea and Abyssinia collected during the British Abyssinian Expedition of 1867-68, and described in his *Obs. Geol. Zool. Abyssinia*, 1870; Blanford also presented some skins from Baluchistan and eastern Iran obtained during the travels of the Persian Boundary Commission, 1870-72, and described in *Eastern Persia*. Vol. II, *Zool. & Geol.*, 1876, by Blanford); Dr. F. Stoliczka (a large series of excellently preserved skins from Kashmir and Eastern Turkestan obtained during Forsyth's Second Yarkand Mission of 1873-74 during which Stoliczka lost his life—the results were published by Sharpe in *Sci. Results Second Yarkand Miss.: Aves*, 1881); Dr. J. Scully (a fine collection of skins from Eastern Turkestan, especially from the neighbourhood of Yarkand, made in 1874-75, and described by him in *Str. Feath.* IV, pp. 41-205, 1876; and a smaller collection from Nepal made in 1878 and described by him in *Str. Feath.* VIII, pp. 339-342, 1879); Surgeon J. Armstrong (1878, a large and excellent series of skins from the Konkan Coast, especially Ratnagiri District and the immediately adjoining areas[1]); Dr. J. E. T. Aitchison (a few skins from the Afghanistan-Iran frontier collected during the travels of the Afghan Boundary Commission of 1885, and described by Sharpe in *Trans. Linn. Soc. Lond.* (2) V pp. 66-93, 1889); C. B. Rickett (1890-91, some skins from Foochow in eastern China); Lt.-Col. Dr. A. W. Alcock (some skins from the Pamirs, collected during the Pamir Boundary Commission of 1896, and described by him in 1898 in *Rept. Nat. Hist. Results Pamir Bound. Comm.*); C. B. Antram (several skins collected in about 1904 or earlier from the Sylhet Division in Assam); Dr. S. W. Kemp (a few skins collected in the Abor country in north Assam during the British Abor Expedition of 1911-12, and described by Stuart Baker in *Rec. Ind. Mus.*, VIII, pp. 286, 287, 1913); and Dr. S. C. Law (a few skins from Bihar collected in 1927). Apart from these, there are a number of skins from the Trivandrum Museum and

[1] Sclater (1892, p. 70) wrongly refers the Armstrong collection to the Malabar Coast. Surgeon J. Armstrong, who belonged to the Marine Survey of India, collected extensively in the Ratnagiri District and adjoining areas (portions of Savantvadi and Kolhapur States) mostly during 1877-1878. An account of his collections, as far as I know, was never fully published, but the collections were deposited in the Indian Museum, Calcutta. The localities from which Armstrong's Columbae skins came are: "Waghotan" (=Vaghotan), "Fanasgaon" (=Phanasgaon) and "Bhoura" or "Bhowra" which is the name given on the labels, but cannot be satisfactorily traced. I have identified it with Bavda (town and *taluk*) in the Kolhapur State not far from the Ratnagiri District-Kolhapur Frontier. Vidal (1880) in his list of South Konkan birds also utilised Armstrong's list supplied by the latter; Vidal used the name Bavda which must be the same as "Bhoura" or "Bhowra" used by Armstrong on his labels in the Indian Museum skins. Since the altitude given by Armstrong for "Bhoura" varies from 1,500 to 2,500 feet, he was probably referring to Bavda *taluk* rather than Bavda town. A report on the entire Armstrong collection of birds is under preparation and will be published in due course.

from the former Riddell Museum (Agra); others are labelled as donated by "Mus. Coll. Jaffa" which I cannot locate; as "Mus. Coll." which means (*vide* Sclater, 1892, p. 71) that they were collected by an official collector of the Indian Museum; and finally, a few are presentations or exchanges from foreign museums and societies.

(ii) *Type-specimens.*

Sclater (1892, p. 86) had stated that the types of four species, namely, *Crocopus viridifrons* (Blyth), *Crocopus chlorigaster* (Blyth), *Osmotreron chloroptera* (Blyth) and *Macropygia rufipennis* Blyth, are present in the Indian Museum. Besides these four, I have found that the types of two others, namely, *Muscadivora aenea pusilla* (Blyth) and *Streptopelia decaocto stoliczkae* (Hume), are also present. Some of the particulars given by Sclater differ from my conclusions, and are discussed under the species concerned.

The following types are present in the Indian Museum (Table 2):—

TABLE 2.

Type-specimens of the Columbae in the Indian Museum, Calcutta.

Name.	Nature of type-specimen.	Discussion on
1. *Crocopus phoenicopterus viridifrons* (Blyth).	Lectotype; and one Syntype.	p. 293.
2. *Crocopus phoenicopterus chlorigaster* (Blyth).	Lectotype; and two Syntypes.	p. 294.
3. *Dendrophassa pompadora chloroptera* (Blyth).	Lectotype; and three Syntypes.	p. 299.
4. *Muscadivora aenea pusilla* (Blyth) .	Holotype; and one Syntype.	p. 314.
5. *Streptopelia decaocto stoliczkae* (Hume)	Holotype	p. 351.
6. *Macropygia rufipennis* Blyth ..	Lectotype; and two Syntypes.	p. 343.

(iii) *Indian pigeons and doves unrepresented or poorly represented in the Indian Museum.*

The number indicated within the square brackets gives the number of skins present:

1. *Dendrophassa pompadora pompadora* (Gmelin) [Nil].
2. *Dendrophassa fulvicollis fulvicollis* (Wagler) [Two].
3. *Dendrophassa bicincta leggei* (Hartert) —[One].
4. *Ducula badia badia* (Raffles) —[One].
5. *Ducula badia griseicapilla* Walden —[Two].
6. *Muscadivora aenea aenea* (Linnaeus) —[Two].
7. *Muscadivora aenea insularis* (Blyth)—[Nil].
8. *Columba leuconota gradaria* Hartert—[Nil].

9. *Columba torringtoni* (Bonaparte)—[One].
10. *Columba pulchricollis* Blyth—[Nil].
11. *Janthoenas palumboides* (Hume)—[One].
12. *Streptopelia chinensis forresti* Rothschild—[Nil].
13. *Streptopelia chinensis ceylonensis* (Reichenbach)—[Two].
14. *Streptopelia decaocto xanthocyclus* (Newman)—[One].
15. *Oenopopelia tranquebarica murmensis* Hartert—[Two].
16. *Macropygia ruficeps assimilis* Hume—[Nil].
17. *Chalcophaps indica maxima* (Hartert)—[Two].
18. *Chalcophaps indica robinsoni* Stuart Baker—[Two].

(*d*) GENERAL REMARKS

Nomenclature.—In regard to generic and specific nomenclature I have followed Stuart Baker (1928) for the Indian species. Regarding the non-Indian species, I have, as far as possible, followed Peters (1937).

Measurements.—All measurements have been taken on dried museum skins, except in a few cases indicated in the text where the original "fresh" measurements indicated on the labels are given. Doubtful measurements are given within round brackets, while the measurements of juveniles are enclosed within square brackets. The following measurements are given for most skins:—

Wing (W.): From the bend of the wing to the tip of the longest primary with the quills flattened out.

Tail (Tl.): From the base of the central tail-feathers to the tip of the longest tail-feather.

Tarsus (Tr.): From the tarso-metatarsal joint to the metatarso digital joint (base of the middle toe).

Culmen (C.): From the base of the exposed culmen, including cere, to the tip. This is the method adopted by Stuart Baker in the *Faun. Brit. Ind., Birds* (2nd ed.) I, 1922. The "culmen" thus measured differs from the "bill" of some writers, the latter measurement being taken from the junction of the bill with the skull to the tip of the bill.

Localities.—The exact determination of the localities as indicated on the labels gave no end of trouble. For, in most cases neither the Province nor the District was mentioned, and the place-names, familiar enough to the collector, are often not to be found in the usual atlases and sometimes not even in the larger maps. In some cases the older spellings of places differ so markedly from the modern ones as to render their being traced in the gazetteers a most intricate task. Wherever possible I have checked the names from the maps and accounts published along with the report of a particular collection. In this way, it is hoped, that most of the localities have been correctly identified. In nearly every case I have given the Province and, where necessary, the District, as demarcated to-day, along with the place-names.

Abbreviations used.—The following abbreviations have been used throughout:

♂, ♀—Male and female respectively in which the sex was *presumably originally determined by an examination of the gonads*, since it is clearly indicated on the original collector's label or in the Indian Museum registers. Many of the older specimens bear the mark ♂; this has been

interpreted as ♂, and in some cases it has been possible to test the accuracy of this interpretation by reference to the plumage of the specimens.

(♂), (♀) Male and female respectively as determined by an examination of plumage alone. The gonads were not examined for the determination of sex, as is indicated by the absence of sexing on the original collector's labels or in the Indian Museum registers.

C. Length of culmen.
L. Total body length.
Reg. No. Registered number of specimen in the Zoological Survey of India (Indian Museum), Calcutta.
Tl. Length of tail.
Tr. Length of tarsus.
W. Length of wing.
X. Length, along rhachis, of the white tip of the left outermost tail-feather.

(e) ACKNOWLEDGMENTS.

I am deeply grateful to Dr. Baini Prashad, the Director, for ready advice and help throughout the preparation of this Catalogue and for his kindness in writing the Foreword. To Dr. S. L. Hora and Dr. B. N. Chopra I am indebted for kindly going through a portion of the manuscript and suggesting useful changes. Dr. T. J. Job kindly read through the proofs for which I am indebted to him. Finally, to the late Dr. Claud B. Ticehurst[1] I owe a debt of gratitude for critically reading through the whole manuscript and giving me the benefit of his mature ornithological experience. As a result of his advice the Catalogue has improved in many ways.

Some species and subspecies previously unrepresented in the Indian Museum have recently been acquired for the Museum through the courtesy of the following gentlemen whose assistance is gratefully acknowledged: Dr. P. E. P. Deraniyagala, Director, Colombo Museum, Ceylon; Dr. F. N. Chasen, Director, Raffles Museum, Singapore; and Mr. C. M. Inglis, Curator, Natural History Museum, Darjeeling.

III. SYSTEMATIC ACCOUNT.

(a) INDIAN SPECIES

The following Indian species and subspecies are listed in the present Catalogue :—

TRERONIDAE.

TRERONINAE

CROCOPUS Bonap.

C. phoenicopterus (Lath.), p. 292.
C. p. phoenicopterus (Lath.), p. 292.
C. p. viridifrons (Bly.), p. 293.
C. p. chlorigaster (Bly.), p. 294.

DENDROPHASSA Glog.

D. pompadora (Gmel.), p. 296.
D. p. phayrei (Bly.), p. 296.
D. p. affinis (Jerd.), p. 297.
D. p. chloroptera (Bly.), p. 299.
D. fulvicollis (Wagl.), p. 300.
D. f. ?fulvicollis (Wagl.), p. 300.

[1] Dr. Ticehurst died on February 17, 1941.

Family TRERONIDAE.

Subfamily *TRERONINAE.*

Genus **Crocopus** Bonaparte.

Crocopus phoenicopterus (Latham).

The genus *Crocopus* contains a single species, *C. phoenicopterus*, with four subspecies as admitted by Peters (1937, p. 23); of these, three occur within the Indian limits.

Crocopus phoenicopterus phoenicopterus (Latham).

(The Bengal Green Pigeon.)

1790. *Columba phoenicoptera*, Latham, *Index Orn.* II, p. 597, No. 13. (India.)
1849. *Treron (Treron) phoenicoptera*, Blyth, *Catal. Mus. Asiat. Soc. Bengal*, p. 229, No. 1384.
1928. *Crocopus phoenicopterus phoenicopterus*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 181. (Latham's type-locality wrongly quoted as "in insula Eimeo".)
1937. *Treron phoenicoptera phoenicoptera*, Peters, *Check list Birds World* III, p. 23.

Crocopus phoenicopterus phoenicopterus is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
26460	♂	Calcutta (vicinity). ..	1842-46 ..	Asiat. Soc. Bengal.	195	123	29	18
26461	♀	Calcutta (vicinity). ..	1842-46 ..	Asiat. Soc. Bengal.	188	..	30	18
3935	♂	Gauhaty (Assam). ..	Mar. 1, 1870	"Mus. Coll."	204	127	32	18
24564	(♂?)	South Sylhet (Assam).	(?)	C. B. Antram.	174	107	27	18
24565	♀	South Sylhet (Assam).	(?)	C. B. Antram.	176	113	29	19
24583	♂	South Sylhet (Assam).	(?)	C. B. Antram.	181	118	26	17·5
26162	♂	(?)	Jan. 7, 1914..	Zool. Gardens, Calcutta.	163	118	27	19
26163	(?)	(?)	Jan. 1, 1914..	Zool. Gardens, Calcutta.	182	113	26	16·5

Remarks. Nos. 26460 and 26461 were listed by Blyth (1849, p. 229, Nos. 1384*A* and *B* respectively). Nos. 24564 (♂?) and 24565, ♀, both from South Sylhet, Assam, are rather small birds (wing: 174-176 mm.), but another from the same locality is larger. Three Assam birds recorded here, *viz.*, Nos. 24564, 24565 and 3935, distinctly belong to *phoenicopterus*, but No. 24583 from South Sylhet appears to be intermediate between *phoenicopterus* and *viridifrons* as is shown by the upper tail-coverts tending to be grey rather than yellowish olive-green.

Distribution.—"Northern India from the southern base of the Himalayas east to Assam, south to central India, Bengal and southern Assam" (Peters).

Crocopus phoenicopterus viridifrons (Blyth).

(The Burmese Green Pigeon.)

1845. *Treron viridifrons*, Blyth, *Journ. Asiat. Soc. Bengal* XIV, Pt. 2, p. 849. ("Tenasserim provinces"=Mergui, S. Burma, *vide* below.)
1849. *Treron (Treron) viridifrons*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 228, No. 1383.
1928. *Crocopus phoenicopterus viridifrons*, Stuart Baker, *Faun. Brit. Ind.*, *Birds* (2nd ed.) V, p. 183.
1937. *Treron phoenicoptera viridifrons*, Peters, *Check-list Birds World* III, p. 23.

Crocopus phoenicopterus viridifrons is represented in the collection of the Indian Museum by the following skins:

Reg No.	Sex.	Locality	Date	Collector or Donor.	Measurements (mm.)			
					W.	Tl.	Tr.	C.
22202	♂	Myitkyina (Burma). .	Mar. 18, 1897	Capt. E. Pottinger.	192	123	30	19
3037	♂	Burma . .	1865 .	Dr. Williams.	184	116	20	18
3038	♂	Burma.	1865 .	Dr. Williams.	174	114	25	17·5
9086	♂	Tamilone (Upper Burma)	Feb. 6, 1868	Dr. J. Anderson.	188	106	26	19
9087	♀	"Tongine"-Tsagine (Upper Burma).	Dec. 29, 1870	Dr. J. Anderson.	190	107	30	18
23520	♂	Maymyo (Upper Burma).	Nov. 2, 1899	Col. C. T. Bingham.	183	116	28	19
23224	(♀?)	Yatsauk (Shan States).	Jan. 15, 1900	Col. C. T. Bingham.	190	110	27	17
5898	(?)	Arakan (Burma). ..	(?)	"Mus. Coll."	197	124	28	17
26485 (Syntype).	(?)	Mergui (Tenasserim, Burma)	1846 ..	Rev. J. Barbe (Asiat. Soc. Bengal).	180	115	(36)	19
26486 (Lectotype).	(?)	Mergui (Tenasserim, Burma).	1846 ..	Rev. J. Barbe (Asiat. Soc. Bengal).	185	109	28	19

Remarks.—Nos. 26485 and 26486 bear identical labels as follows: "Type No. 1383, *Crocopus viridifrons* Blyth, Mergui, Rev. J. Barbe, 1846, A.S.B." On the outer paper wrapper of each specimen is also written: "Type of sp.". They are thus the two specimens recorded by Blyth (1849, p. 228, No. 1383, *A*, *B*). Presumably, Blyth (1845, p. 849) originally described his bird from one of these specimens. Since it is not possible to determine which of these two specimens is Blyth's type, they must be regarded as the Syntypes; of these, I select the better preserved specimen, No. 26486, as the Lectotype.

Type-locality.—Blyth (1845, p. 849) had stated that his birds came from the "Tenasserim provinces", which in those days included a considerable portion of Burma from about 19°N. to 10°N. latitudes. Since Blyth's birds actually came from Mergui, this place becomes the type-locality. It may be added that there seem to be no other records from as far south as Mergui—Oates's (1883, p. 307) southern limit was Moulmein, while Hume (1888, p. 290) gave it as northern and central Tenasserim.

Distribution.—"Burma, northern Tenasserim and northwestern Siam" (Peters).

Crocopus phoenicopterus chlorigaster (Blyth)[1].

(The Southern Green Pigeon.)

1843. *Vinago chlorigaster*, Blyth, *Journ. Asiat. Soc. Bengal* XII, Pt. 1, p. 167, foot-note. (No locality. Southern India by Blyth, *Ann. Mag. Nat. Hist.* XIV, p. 116, 1844: restricted to Salem District, Madras Presidency, by Whistler & Kinnear, *Journ. Bombay Nat. Hist. Soc.* XXXVIII, p. 672, 1936.)

1849. *Treron (Treron) chlorigaster*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1385.

1928. *Crocopus phoenicopterus chlorogaster*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 184.

1937. *Treron phoenicoptera chlorigaster*, Peters, *Check-list Birds World* III, p. 23.

Crocopus phoenicopterus chlorigaster is represented in the collection of the Indian Museum by the following skins: –

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
3939	♂	Cawnpore (U. P.). ..	Dec. 28, 1869	E. Buck. ..	185	(120)	27	18
3940	♂	Cawnpore (U. P.). ..	Oct. 25, 1869	E. Buck. ..	185	129	33	18
3941	♂	Cawnpore (U. P.). ..	Oct. 25, 1869	E. Buck. ..	187	129	29	17
3943	♂	Cawnpore (U. P.). ..	Oct. 25, 1869	E. Buck. ..	188	121	30	18
3944	♂	Cawnpore (U. P.). ..	Oct. 25, 1869	E. Buck. ..	176	113	23	19
3945	♀	Cawnpore (U. P.). ..	Oct. 25, 1869	E. Buck. .	172	107	(32)	18
3942	(?)	Cawnpore (U. P.). ..	(?)	E. Buck. ..	185	107	30	16
3959	♂	Agra (U. P.). ..	Mar. 1868 ..	"Riddell Mus."	185	118	30	16
3958	♀ (Juv.)	Agra (U. P.). ..	Mar. 1868 ..	"Riddell Mus."	[182	122	26·5	18]
3955	♂	Bind(a)ra (C. P.). ..	(?)	Mr. W. T. Blanford.	187	119	28·5	19·5
3961	(?)	N. E. Chanda (C. P.).	Feb. 7, 1869	Mr. W. T. Blanford	190	..	30	17·5
3954	(?)	Nagpur (C. P.). ..	(?)	Mr. W. T. Blanford.	192	125	28	17·5
3960	♂	S. E. Berar. ..	Mar. 1870 ..	Mr. W. T. Blanford	177	108	28	17
3951	♂	Udipur (west Chota Nagpur, C. P.).	Jan. 4, 1870..	Mr. W. T. Blanford.	187	121	27	17·5
3952	♀	Chota Nagpur. ..	Nov. 29, 1868	Mr. V. Ball.	178	107	27	18
3950	(?)	Chota Nagpur. ..	Dec. 9, 1868	Mr. V. Ball.	187	119	26	(18)
26464	♂	Burkul Is. (Chilka Lake, Orissa).	July 1914 ..	Dr. S. W. Kemp.	181	120	25	17
25744	♀	Near Ramgarh (Ranchi Dist., Bihar).	Oct. 18, 1927	Dr. S. C. Law.	187	(111)	27	17
3946	♀	Manbhum (Bihar). ..	Jan. 1865 ..	Lt. R. C. Beavan.	179	110	26	19
3948	(?)	Manbhum (Bihar). ..	(?)	Lt. R. C. Beavan.	190	117	26	19·5
3947	(?)	Manbhum (Bihar). ..	Feb. 1865 ..	Lt. R. C. Beavan.	177	105	26	16·5

[1] The original spelling is *chlorigaster*. Several writers, including Stuart Baker (1928, p. 184), have wrongly used *chlorogaster*.

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
3949	♀ (Juv.)	Manbhum (Bihar). ..	(?)	"Mus. Coll"	[183	117	27	17]
3932	(?)	Manbhum (Bihar). ..	(?)	"Mus. Coll"	196	125	28	..
3931	(?)	Singhbhum (Bihar). ..	(?)	Mr. V. Ball.	185	110	27	16
3956	(?)	Singhbhum (Bihar). ..	Dec. 10, 1868	Mr. V. Ball.	187	(120)	28	17
3933	(?)	Daminiok (Bihar ?). ..	(?)	Mr. V. Ball.	187	118	30	20
3930	(?)	Daminiok (Bihar ?). ..	(?)	Mr. V. Ball.	183	114	29	16·5
3934	(?)	Daminiok (Bihar ?). ..	(?)	Mr. V. Ball.	187	123	28	18
25767 (Mounted in gallery.)	♂	"Palamau border" (Ranchi Dist., Bihar).	Oct. 23, 1927	Dr. S. C. Law.	196	(126)	..	19
11828	♂	Fanasgaon (=Phanasgaon, Ratnagiri Dist., Bombay Pres.).	Mar. 15, 1878	Surg. J. Armstrong.	194	123	29	18·5
11829	♀	Fanasgaon (=Phanasgaon, Ratnagiri Dist., Bombay Pres.).	Mar. 17, 1878	Surg. J. Armstrong.	175	109	28	17
11830	♀	"Bhoura" (=Bavda, 2,000 ft., Kolhapur State, Bombay Pres.).	Feb. 12, 1878	Surg. J. Armstrong.	181	122	27	17
18443	♂	N. Bangalore (Mysore State).	(?)	"Mus. Coll."	183	122	26	17
18547	♀	N. Bangalore (Mysore State).	(?)	"Mus. Coll."	179	110	27	..
18514	♂	S. Arcot Dist. (Madras Pres.).	(?)	"Mus. Coll."	175	101	26	17
18515	♂	S. Arcot Dist. (Madras Pres.).	(?)	"Mus. Coll."	172	99	27	18
18516	♀	S. Arcot Dist. (Madras Pres.).	(?)	"Mus. Coll."	171	(110)	25	16
26482 (Lectotype).	(?)	(?)	(?)	Asiat. Soc. Bengal.	197	130	30	18
26483 (Syntype).	(?)	(?)	(?)	Asiat. Soc. Bengal.	170	118	..	18
26484 (Syntype).	(?)	(?)	(?)	Asiat. Soc. Bengal.	182	111	..	19

Remarks.—Nos. 26482, 26483 and 26484 bear identical labels: "Type No. 1385. *Crocopus chlorigaster* Blyth. No further history. A. S. B." Two of the specimens bear, in addition, the following particulars: "Blyth, J. A. S. XII, p. 167. S. India; rare in Bengal." On the paper wrapper of each of the three specimens is written, among other notes, the following: "One of these is type." No doubt, these are the three specimens which were listed by Blyth (1849, p. 229, No. 1385, *A*, *B*, *C*). *A* and *B* are males, while *C*, "from the vicinity of Calcutta 1841-6)", is female. It was presumably from one of these three specimens that Blyth (1843, p. 167) originally described this bird; since Blyth's original specimen was a female, it was presumably No. 1385*C* of his *Catalogue*, but *A* and *B* cannot be placed, so that it is not possible to say which of the three Indian Museum specimens is No. 1385*C*,

Under these circumstances, I regard the three Indian Museum specimens as the Syntypes of the species, and select the best preserved specimen, No. 26482, as its Lectotype.

Sclater (1892, p. 86) listed only one type-specimen of *chlorigaster*, with the locality "Near Calcutta" and the donor "E. Blyth". I find nothing, either on the labels or on the outer wrappers of the skins, to support Sclater. Again, he wrongly gave Blyth's name as *Treron chlorigaster* instead of *Vinago chlorigaster*.

From the specimens in the Indian Museum, the following is indicated:—Specimens from Cawnpore and Agra in the United Provinces are intermediate in plumage between *chlorigaster* and *phoenicopterus*. While their breast and abdomen are yellowish as in true *chlorigaster*, there is a more or less clear basal band of yellowish-green on the tail. Only in one specimen (No. 3911, ♂, Cawnpore) is the tail ashy throughout as in *chlorigaster*.

Similarly, in respect of tail coloration, specimens from southern Bihar (Singhbhum, Manbhum, Ranchi and ?Daminiok) and Orissa (Chilka Lake), are intermediate between *chlorigaster* and *phoenicopterus*.

Discussing its distribution in the Eastern Ghats (Madras Presidency), Whistler & Kinnear (1936, p. 672) state that specimens from the Madras Presidency appear to be smaller than those from the central belt of the Indian peninsula (wing 182-184 mm., as against 203 mm.). Birds from the Ratnagiri District (Bombay Presidency), Bangalore and Arcot in the Indian Museum collection, however, are not appreciably smaller than North Indian birds as shown below:

Wing (mm.).

N. India (down to 18° N. lat.).		*S. India (below 18° N. lat.).*	
10♂♂	167-188	4♂♂	172-194
4♀♀	172-187	4♀♀	174-184
6 o?	177-196	3 o?	170-197

Distribution. "All of the Indian Peninsula south of the range of *p. phoenicoptera*; Ceylon" (Peters).

Genus **Dendrophassa** Gloger.

Dendrophassa pompadora (Gmelin).

The species extends from Ceylon and India *via* Siam (not Malaya) and Cochin China to the Philippines and the East Indies. Peters (1937, pp. 15-17) recognises seventeen subspecies of which four occur within the Indian limits.

Dendrophassa pompadora phayrei (Blyth).

(The Ashy-headed Green Pigeon.)

1849. *Treron (Treron) malabarica* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1389.
1862. *Osmotreron Phayrei*, Blyth, *Journ. Asiat. Soc. Bengal* XXXI, p. 344. (Tounghoo, Burma.)
1928. *Dendrophassa pompadora phayrei*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 186.
1937. *Treron pompadora phayrei*, Peters, *Check-list Birds World* III, p. 16.

Dendrophassa pompadora phayrei is represented in the collection of the Indian Museum by the following skins: —

Reg No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
21581	♂	S. Sylhet (Assam)	(?)	C. B. Antram.	149	83	23	15
5801	♀	Lamagooting (Assam).	(?)	Capt. Butler.	153	102	23	11
5897	♂	Arakan (W. Burma).	(?)	"Mus. Coll."	151	101	25	11
26451	♂	Arakan (W. Burma).	1843	Capt. J. R. Abbott.	147	92	25	16
26452	♂	Arakan (W. Burma).	1843	Capt. J. R. Abbott.	150	95	26	14
5896	♀	Arakan (W. Burma).	(?)	"Mus. Coll."	150	96	23	16
8135	♀	Meetan (Tenasserim, Burma)	Jan. 18, 1877	Dr J. Anderson (Tenasserim Exped.).	143	90	22	16
8134	♂	Meetan (Tenasserim, Burma).	Feb. 8, 1877	Dr. J. Anderson (Tenasserim Exped.).	152	93	20	14
24227	♂	(?)	July 15, 1902	(?)	140	88	22	17

Remarks. Nos. 26451 and 26152 were listed by Blyth (1849, pp. 229, 230, No. 1389 *A*, *B* respectively). The specimens are in poor condition and the plumage is faded, but they can clearly be distinguished from *D. p. affinis* by the ashy patch on the crown and the remnants of the orange patch on the forebreast.

Distribution. "Bengal eastward through Assam to Laos, south to Calcutta, Tenasserim, continental Siam and Cochinchina" (Peters).

Dendrophassa pompadora affinis (Jerdon).

(The Grey-fronted Green Pigeon.)

1840. *Vinago affinis* (♀), Jerdon, *Madras Journ. Lit. & Sci.* XII, p. 13. (West coast of Indian Peninsula.)
1845. *Vinago malabarica* (♂), Jerdon, *Illustr. Ind. Orn.* III, letterpress to pl. 21.
1849. *Treron (Treron) malabarica* (part), *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1389.
1928. *Dendrophassa pompadora affinis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 188.
1937. *Treron pompadora affinis*, Peters, *Check-list Birds World* III, p. 15.

Dendrophassa pompadora affinis is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
11832	♂	"Bhoma" (Bavda), 2,000 ft., Kolhapur State, Bombay Pres.	Mar. 28, 1878	Surg. J. Armstrong.	142	[illegible]	29	11
26140	♂	"Bhoma" (Bavda), 2,500 ft.	Mar. 28, 1878	Surg. J. Armstrong.	147	101	22	15

Reg No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm).			
					W.	Tl.	Tr.	C.
11038	♂	" Bhoura " (– Bavda), 2,500 ft.	Mar. 28, 1878	Surg. J. Armstrong.	142	102	21	15
11831	♂	" Bhoura " (Bavda), 2,000 ft.	Mar. 30, 1878	Surg. J. Armstrong.	149	101	23·5	16
11834	♂	" Bhoura " (Bavda), 2,000 ft.	Apr. 14, 1878	Surg. J. Armstrong.	142	101	23	..
11146	♂ (Juv.)	" Bhoura " (Bavda), 2,500 ft.	Mar. 29, 1878	Surg. J. Armstrong.	[135	82	23	10]
11323	♀	" Bhoura " (– Bavda), 2,000 ft.	Mar. 28, 1878	Surg. J. Armstrong.	143	92	20	13
11039	♀	" Bhoura " (– Bavda), 2,500 ft.	Mar. 28, 1878	Surg. J. Armstrong.	149	98	25	13
11325	♀	" Bhoura " (= Bavda).	Mar. 28, 1878	Surg. J. Armstrong.	141	85	22	14
11833	♀	" Bhoura " (– Bavda), 2,000 ft.	Apr. 6, 1878	Surg. J. Armstrong	145	102	21	13
11835	♀	" Bhoura " (– Bavda), 2,500 ft.	Apr. 10, 1878	Surg. J. Armstrong.	139	92	23	12
11326	♀ (Juv.)	" Bhoura " (= Bavda), 2,000 ft.	Apr. 18, 1878	Surg. J. Armstrong.	[134	80	22	15]
11088	♀ (Juv.)	" Bhoura " (= Bavda), 2,500 ft.	Mar. 29, 1878	Surg. J. Armstrong.	[139	79	21	18]
18120	♂	Shevaroy Hills (Madras Pres.).	(?)	W. Daly.	146	96	21·5	10
23028	(♂)	Ponmudi (Travancore).	April 1895	Trivandrum Mus.	139	97	21	15

Remarks. No. 11146, ♂ (juv.), has no maroon on the back and is indistinguishable from the juvenile females, Nos. 11326 and 11088. No. 11326 is labelled only as " ♀ " ; because of its small size and the condition of the feathers of the back I consider it as juvenile.

The males and females of *D. p. affinis* are very similar in appearance and size to those of *D. p. phayrei*, but the former subspecies can be distinguished from the latter by the following characters : (1) In *affinis* the ashy patch on the crown, forehead and foreneck is less pure (being mixed with an olive-green tinge) and gradually merges into the olive-green of the hindneck and back instead of being more or less sharply defined as in *phayrei*. (2) The complete absence in *affinis* of the orange patch of the forebreast which is present, though sometimes very faint or even absent, in *phayrei*. (3) The maroon-chestnut of the back is darker (having almost a purplish tinge) in *affinis* than in *phayrei*. (4) A fourth point in which the two subspecies differ needs mention. Stuart Baker (1928, p. 185) mentions in the key to the species of *Dendrophassa* that all the Indian subspecies of *D. pompadora* have the " tibial plumes in both sexes buff or yellowish ". The series of skins in the Indian Museum, however, shows the following characters :—

D. pompadora affinis.—Tibial plumes deep lemon-yellow in ♂, but generally white (sometimes faintly lemon yellow mixed with white) in ♀.

D. pompadora phayrei.—Tibial plumes white in both the sexes.

Distribution.—" Western India from Bombay to southern Travancore " (Peters).

Dendrophassa pompadora chloroptera (Blyth).

(The Nicobar Green Pigeon)[1].

1845. *Treron chloroptera*, Blyth, *Journ. Asiat. Soc. Bengal* XIV, p. 852. (Nicobar Islands.)
1849. *Treron (Treron) chloroptera*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1388.
1903. *Osmotreron chloroptera andamanica*, Richmond, *Proc. U. S. Nation. Mus.* XXV, p. 308.
1928. *Dendrophassa pompadora chloroptera*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 188.
1937. *Treron pompadora chloroptera*, Peters, *Check-list Birds World* III, p. 16.

Dendrophassa pompadora chloroptera is represented in the collection of the Indian Museum by the following skins :

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.)			
					W.	Tl.	Tr.	C.
25024	♂	Bonnington (N. Andaman Is.).	Feb. 17, 1930	Zool. Survey of India.	171	107	26	18
25025	♀	Bonnington (N. Andaman Is.).	Feb. 17, 1930	Zool. Survey of India.	175	108	28	19
18667	♀	Anikhet (S. Andaman Is.).	Mar. 13, 1890	G. H. Booley	170	101	27	17.5
3918	♂	Andamans. ..	(?)	Dr. G. E. Dobson	170	(95)	23	..
26487 (Lectotype).	(♂)	Nicobars.	1845	Rev. J. Barbe (Asiat. Soc. Bengal).	178	111	(31)	19
26488 (Syntype)	(♂)	Nicobars.	1845	Capt. Lewis & Rev. J. Barbe (Asiat. Soc. Bengal).	167	98	..	17
26489 (Syntype).	(♀)	Nicobars.	1845	Capt. Lewis & Rev. J. Barbe (Asiat. Soc. Bengal).	171	101	..	(20)
26490 (Syntype).	(♀)	Nicobars.	1845	Capt. Lewis & Rev. J. Barbe (Asiat. Soc. Bengal).	170	105	29	..

Remarks. Nos. 26488 (♂), 26489 (♀) and 26490 (♀) bear the labels : " Type No. 1388, *Treron chloroptera* Blyth, *A, B* & *C*, Nicobars, Capt. Lewis & Rev. J. Barbe, 1845, A. S. B.". No. 26487 (♂) is similarly labelled except that only one collector's name (Rev. J. Barbe) is given, and the letters " *A, B,* & *C* " are not given. On the outer paper wrapper of each specimen is also written : " Type of sp. Bly " no doubt meaning 'Type of species of Blyth'. The three specimens recorded by Blyth (1849, p. 229, No. 1388, *A, B, C*) most probably form part of the series of four specimens mentioned above ; Blyth records : *A* ♂ and *B* ♀ collected by Capt. Lewis, and *C* ♂ by Rev. J. Barbe, all obtained from the Nicobars in 1845. Presumably, it was from one of these four specimens that Blyth (1845, p. 852) described the species. I have taken the four specimens mentioned above as the Syntypes. Of these,

[1] This name is preferable to " Andaman Green Pigeon " employed by Stuart Baker (1928, p. 188) because (i) the typo-locality is Nicobars, not Andamans ; and (ii) more than one race is recognised by some authors in the Andamans and the Nicobars.

No. 26487 (♂, Rev. J. Barbe) is presumably the same as Blyth's specimen (No. 1388 C, ♂, Rev. J. Barbe), and since this is also the better preserved of the two males, I select it as the Lectotype.

There has been much diversity of opinion regarding the number of races occurring in the Andaman and the Nicobar groups of islands. Hume (1874, p. 258) regarded the Nicobar birds as somewhat different from the Andaman birds, but did not consider the differences sufficiently marked for the separation of the races. Richmond (1903, p. 308) described S. Andaman birds as much smaller and darker than the Nicobar birds, but according to Stuart Baker (1928, p. 188) no such distinction holds good in a series.

Andaman and Nicobar birds in the Indian Museum collection cannot be separated as regards measurements as shown below :

		Wing (mm.)	Tail (mm.)
Andamans	2♂♂	170-171	(95)-107
	2♀♀	170-175	101-108
Nicobars	2 ♂♂	167-178	98-111
	2 ♀♀	170-173	104-105

No. 3918, ♂, Andamans, differs from the other specimens in being comparatively small and also much darker throughout ; the lower plumage shows some brownish tinge on the lower breast.

Distribution. "Nicobar and Andaman Islands" (Peters).

Dendrophassa fulvicollis (Wagler).

This species extends from Tenasserim (S. Burma) in the west, through Malaya and French Indo-China, to some of the islands in the East Indies, *viz.*, Sumatra, Borneo, Billiton, etc. Peters (1937, pp. 17, 18) recognises four subspecies of which only *D. f. fulvicollis* occurs within the Indian limits.

Dendrophassa fulvicollis ?fulvicollis (Wagler).

(The Cinnamon-headed Green Pigeon.)

1827. *Columba fulvicollis*, Wagler, *Syst. Av., Columba*, sp. 8. (Java=Sumatra.)
1928. *Dendrophassa fulvicollis fulvicollis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 189.
1937. *Treron fulvicollis fulvicollis*, Peters, *Check-list Birds World* III, p. 17.

Dendrophassa fulvicollis ?fulvicollis is represented in the collection of the Indian Museum by the following skins :

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
20417	♂	Kuching (Sarawak, Borneo).	Nov. 23, 1896	Sarawak Mus. (Borneo).	143	103	22	15
20448	(♂)	(?)	(?)	(?)	140	93	23	13

Remarks. Having had no opportunity of comparing the two specimens here recorded with other subspecies of *D. fulvicollis*, I have placed them under *D. f. fulvicollis* on distributional grounds only. No. 26447 is from south-western Borneo and, therefore, may perhaps not be referred to *D. f. barmensis* which occurs only in northern Borneo. No. 26448 (no history) appears to be an old specimen and is hardly distinguishable from No. 26447.

Distribution. "Tenasserim south through the Malay States and Malay Archipelago to Sumatra; Rhio Archipelago; southern Borneo; islands of Billiton and Banka; Cochinchina (?)" (Peters).

According to Delacour and Jabouille (1931, p. 12; 1940, p. 114) it occurs sparingly in French Indo-China and Cochin China.

Dendrophassa bicincta (Jerdon).

The species extends from the United Provinces (India) in the west and Ceylon in the south, and *via* the Malay Peninsula, Siam, and Indo-China to the Island of Hainan in the north-east, and to Java and the Island of Sao Thome and Rollas islet in the Gulf of Guinea in the east. It is not recorded from the intermediate islands of the East Indies. Peters (1937, pp. 19, 20) recognises four subspecies, namely, *bicincta*, *leggei*, *domvilii* and *javana*, of which the first two occur within the Indian limits. The subspecies *praetermissa* Robinson & Kloss, which is accepted by Stuart Baker (1928, p. 193), is united with *bicincta* by Peters. Although *praetermissa* is very difficult to distinguish from *bicincta*, and no satisfactory distinguishing characters have yet been given, I have tentatively accepted it as distinct and referred to it all the specimens from the range as defined by Stuart Baker (1928).

I have found it quite impossible to distinguish individual specimens of the races *bicincta*, *leggei* and *praetermissa* on plumage characters, while size differences in small collections are of little help.

Inglis (1927, p. 17) has recorded *D. b. domvilii* (Swinhoe) from the Bengal Duars! This is presumably due to wrong identification of *D. b. bicincta*, as *domvilii* occurs only in the Island of Hainan off the coast of S. E. China.

Dendrophassa bicincta bicincta (Jerdon).

(The Indian Orange-breasted Green Pigeon.)

1840. *Vinago bicincta* (♂), Jerdon, *Madras Journ. Lit. & Sci.* XII, p. 13, No. 289. (Sea-coast south of Tellichery, Madras Presidency.)

1849. *Treron (Treron) bicincta* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1386.

1928. *Dendrophassa bicincta bicincta*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 191.

1937. *Treron bicincta bicincta* (part), Peters, *Check-list Birds World* III, p. 19.

Dendrophassa bicincta bicincta is represented in the collection of the Indian Museum by the following skins: –

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
2921	(♀)	Travancore .	(?)	Asiat. Soc. Bengal.	156	99	24	15
18399	♀	S. Mangalore (Madras Pres.).	(?)	Dr. J. Scully	157	100	25	16
3923	♂	Manbhum (Bihar).	Dec. 16, 1864	Lt. R. C. Beavan.	151	95	21	17
26521	♂	Midnapore Dist. (Bengal).	Nov. 25, 1938	Mr. A. E. F. Wood.	148	108	23	15·5

Remarks. No. 2921 from Travancore is sexed as a "♁" = ♂, but has the plumage of a ♀. No. 26521, ♂, Midnapore District, Lower Bengal, is an exceptionally small specimen, with wing 148 mm. only; in this respect it resembles the Ceylon race *leggei*. A ♂ (No. 3923) from Manbhum (Bihar) is also rather small, with wing only 151 mm. The wing-length given by Stuart Baker (1928, pp. 191-193) for males of *D. b. bicincta* is 153-164 mm., once 170 mm.; and for *leggei* 140-146 mm., once 149 mm.

The length of the culmen is given by Stuart Baker (*loc. cit.*) as 12-13 mm.; in the Indian Museum birds it is 15-17 mm.

Distribution. Peters (1937, p. 19) does not separate *praetermissa* from the typical *bicincta*, as was done by Stuart Baker (1928, p. 192). The latter gives the following range of *D. b. bicincta*: Malabar Coast, perhaps excluding Travancore; North India from the United Provinces along the Terai through foot hills and adjoining plains to east Assam north of the Brahmaputra; Bengal and Bihar, but replaced in the extreme east, *i.e.*, Assam south of the Brahmaputra, Comilla and Chittagong, by the closely allied and hardly distinguishable race *praetermissa*; rare (probably only a winter visitor) in Chota Nagpur; more common in Manbhum, Purulia and the adjoining eastern districts.

In the Indian Museum there is a female from Travancore which, by its wing-length (156 mm.), should be assigned to *bicincta* and not to *leggei* which is said to occur in southern Travancore although satisfactory evidence for the latter view is wanting.

Recently, Eates (1938, p. 330) found a stray specimen of *D. b. bicincta* as far west as Kiamari (Karachi, Sind). This is considerably beyond the hitherto known western range of the subspecies. Eates opined that the bird might possibly have been driven so far south-westwards by the prevalent cold wave.

Whistler & Kinnear (1936, p. 673) have discussed its distribution in South India, and have shown that this bird is fairly common both in the eastern and western portions of the Madras Presidency. They further note that the status of Malabar birds is not yet clear.

Dendrophassa bicincta leggei (Hartert).

(The Ceylon Orange-breasted Green Pigeon.)

1849. *Treron (Treron) bicincta* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1386.
1910. *Treron bicincta leggei*, Hartert, *Novit. Zool.* XVII, p. 193. (Ceylon.)
1928. *Dendrophassa bicincta leggei*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 192.
1937. *Treron bicincta leggei*, Peters, *Check-list Birds World* III, p. 19.

Dendrophassa bicincta leggei is represented in the collection of the Indian Museum by the following skin :

Reg No	Sex	Locality	Date.	Collector or Donor	Measurements (mm.).			
					W.	Tl	Ts	C
26566	♂	Vauvonia (North Prov Ceylon).	Apr. 18, 1904	Colombo Mus., Ceylon.	151	106	23	16

Remarks. Stuart Baker (1928, p. 192) gives the wing-length as 140-146 mm. In addition to No. 26566 listed here, I have examined a male from Ceylon (Coll.: Major E. W. Mayor, June, 1914) loaned by the Bombay Natural History Society. Both the males have the wing 151 mm. I am unable to separate these skins from the typical *bicincta*.

Distribution. "Ceylon; birds from the south of Travancore may be referable here" (Peters).

Dendrophassa bicincta praetermissa (Robinson & Kloss).

(The Siam Orange-breasted Green Pigeon.)

1849. *Treron (Treron) bicincta* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1386.
1921. *Treron bisincta* (sic) *praetermissa*, Robinson & Kloss, *Journ. Fed. Malay States Mus.* X, p. 203. (Koh Lak, S. W. Siam.)
1928. *Dendrophassa bicincta praetermissa*, Stuart Baker, *Faun. Brit. Ind. Birds* (2nd ed.) V, p. 193.
1937. *Treron bicincta bicincta* (part), Peters, *Check-list Birds World* III, p. 19.

Dendrophassa bicincta praetermissa is represented in the collection of the Indian Museum by the following skins :

Reg. No	Sex.	Locality	Date.	Collector or Donor.	Measurements (mm.)			
					W.	Tl.	Ts.	C.
24562	(♂)	S. Sylhet (Assam). ..	(?)	C. B. Antram.	152	102	21	16
24563	(Juv. ♂).	S. Sylhet. .	(?)	C. B. Antram.	[151	83	19	17]
24584	(Juv. ♂).	S. Sylhet. ..	(?)	C. B. Antram.	[146	85	22	16]
24560	♀	S. Sylhet. ..	(?)	C. B. Antram.	150	80	23	15
24561	(Juv.)	S. Sylhet. ..	(?)	C. B. Antram.	[139	(81)	23	15.5]
24566	(♂)	S. Sylhet. ..	(?)	C. B. Antram.	147	95	21	..
5895	(♀)	Arakan (W. Burma).	(?)	"Mus. Coll."	151	103	23	17
12949	♂	Pilat (Mergui, S. Burma).	Mar. 9, 1882	Dr. J. Anderson (Mergui Exped.).	152	(61)	23	18
12950	♂	Pilat (Mergui, S. Burma).	Mar. 13, 1882	Dr. J. Anderson (Mergui Exped.).	147	95	24	16

Remarks.—No. 24561 is a juvenile without any trace of the lilac band and orange patch on the breast; Nos. 24563 and 24584 are also juveniles, but the lilac band and orange patch on the breast, which are characteristic of the adult male, are faintly seen.

Robinson & Kloss (1921, p. 203) while creating *praetermissa* remarked: "Larger than *T. b. bisincta* (Jerdon) from Madras (wing 144): differs from *T. b. domvilii* (Swinh.) from Hainan in having the grey nuchal patch in the female clear and more extensive whereas, fide Hartert, it is indistinct and small in the island bird.... Wing 157-163 mm."

Stuart Baker (1928, p. 190, key) stated that *praetermissa* is "lighter and more yellow" than *bicincta*; he further added (p. 193): "Only differs from *D. b. bicincta* in being somewhat more yellow and brightly coloured, hardly sufficiently so to enable one to differentiate it as a subspecies. The female, however, has usually more grey on the nape. ...Measurements as in the Indian bird."

So far as the skins in the Indian Museum are concerned, none of the above distinctions works. The females from Travancore to Burma all look exactly alike. It is, however, possible to distinguish between the two males from Bihar and western Bengal on the one hand, and the three males from southern Sylhet (Assam) and Mergui (southern Burma) on the other. In the former, the dorsal grey patch is larger (50-60 mm. long) and extends from the hind-crown to the foreback; in the latter, the grey patch is much smaller (35-38 mm. long). The grey patch is not sharply defined at either ends, so that the above measurements are approximate. The specimens available to me are too few for generalisation; nevertheless the distinction given here is noteworthy, and may prove to be subspecific.

The few Assamese and Burmese birds in the Indian Museum collection are not larger (wing 147-152 mm.) than those from the rest of India.

Distribution.—Stuart Baker (1930, p. 688) gave the range as: "Assam south of the Brahmapootra; Bengal East of Bay; all Burma". But this does not include the type-locality in S. W. Siam! The range also includes the northern portions of the Malaya Peninsula and western Siam (Robinson & Chasen, 1936, p. 47).

Dendrophassa vernans (Linnaeus).

The species is distributed from southern Tenasserim *via* the Malay Peninsula, Java, Sumatra and Borneo to Celebes in the east, and *via* Siam to Indo-China and possibly a little further up in the north, and the Philippines in the north-east. Peters (1937, pp. 18, 19) recognises eight subspecies of which only *D. v. griseicapilla* occurs within the Indian limits.

Dendrophassa vernans griseicapilla (Schlegel).

(The Malay Pink-necked Green Pigeon.)

1849. *Treron (Treron) viridis* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 229, No. 1387.
1863. *Treron griseicapilla*. Schlegel, *Neder. Tijd. Dierk.* 1, p. 70. (Sumatra and Banka.)

1928. *Dendrophassa vernans griseicapilla*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 194.
1937. *Treron vernans griseicapilla*, Peters, *Check list Birds World* III, p. 18.

Dendrophassa vernans griseicapilla is represented in the collection of the Indian Museum by the following skins :-

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
12951	♂	Yuneekee (Mergui, S. Burma).	Feb. 21, 1882	Dr. J. Anderson.	111	101	24	..
12952	(♀)	Pilai (Mergui, S. Burma).	Mar. 9, 1882	Dr. J. Anderson.	137	88	22	.
17907	♂	Perak (Malay Penin.).	(?)	(?)	111	91	22	17
17908	♂	Perak (Malay Penin.).	(?)	(?)	117	110	21	15
3919	(♂)	Malacca (Malay Penin.).	(?)	(?)	152	96	22	16
26559	♂	Pulau Bintang (Rhio Archipelago).	May 28, 1930	Raffles Mus., Singapore	150	94	25	16
26560	♀	Pulau Bintang (Rhio Archipelago).	May 28, 1930	Raffles Mus., Singapore.	138	..	23	15
12014	♀	(?)	Mar. 11, 1875	W. Rutledge	138	87	21	16
22338	♀	(?)	Nov. 16, 1897	W. Rutledge	134	85	20	15
22339	♀	(?)	Nov. 25, 1897	W. Rutledge	132	(89)	22	15
22340	♀	(?)	Dec. 9, 1897	W. Rutledge	111	98	15	11
22341	♀	(?)	Nov. 26, 1897	W. Rutledge	121	79	21	14
3200	(♂)	Amoy (Fu-Kien, E. China).	(?)	R. Swinhoe	135	92	22	16

Distribution. "Southern Tenasserim, Malay Peninsula, Cambodia, Cochinchina, Sumatra (except northeastern), Rhio Archipelago, Banka, Billiton, western Java and northern Borneo" (Peters).

Delacour & Jabouille (1940, p. 115) also include southern Annam in French Indo-China within its range.

In the Indian Museum there is a skin, No. 3200 (♂), from Amoy, E. China, which is indistinguishable from *griseicapilla*. This seems to be the sole record from E. China La Touche (1932) does not list it from that area.

Genus **Treron** Vieillot.

Treron curvirostra (Gmelin).

The species extends from western Nepal to several islands of the East Indies. Peters (1937, pp. 14, 15), following Hartert, recognises ten subspecies of *T. curvirostra*. Of these only *T. c. nipalensis* occurs within the Indian limits.

As pointed out by Ticehurst (1930, p. 477), Stuart Baker's (1928, p. 195) statement that of *T. curvirostra*, "two races ...*T. c. curvirostra* and *T. c. nipalensis*, extend through the greater part of our area..."

is misleading because it suggests that both the subspecies occur within the Indian limits, though actually only *nipalensis* occurs.

Treron curvirostra nipalensis (Hodgson).

(The Northern Lesser Thick-billed Green Pigeon.)

1836. *Toria Nipalensis*, Hodgson, *Asiat. Res.* XIX, p. 164. (Nepal.)
1928. *Treron curvirostra nipalensis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 196.
1937. *Treron curvirostra nipalensis*, Peters, *Check-list Birds World* III, p. 14.

Treron curvirostra nipalensis is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
26541	♂	"Chupramai" (Jalpaiguri Dist., N. Bengal).	Mar. 19, 1935	C. M. Inglis.	139	83	24	14
26542	♀	"Imenghat Forest" (The Duars, N. Bengal).	Mar. 24, 1928	C. M. Inglis.	139	77	23	15
24578	♂	S. Sylhet (Assam). ..	(?)	C. B. Antram.	139	92	22	11
24579	♂	S. Sylhet (Assam). ..	(?)	C. B. Antram.	142	(95)	24	15
24580	♀	S. Sylhet (Assam). .	(?)	C. B. Antram.	133	80	23	11
12916	♂	Pilal (Mergui, S. Burma).	Mar. 5, 1882	Dr. J. Anderson (Mergui Exped.).	137	90	21	11
26562	♂	Chiengmai, N. Siam. (Purchased as skin.)	Apr. 6, 1937	Raffles Mus., Singapore.	143	92	24	14
26563	♀	Bandon (Peninsular Siam).	July 14, 1929	Raffles Mus., Singapore.	130	76	22	14

Distribution.—"Western Nepal east through Assam and the Shan States to French Indochina, south to Bengal, Tenasserim, Siam and Cambodia" (Peters).

Genus **Butreron** Jacquinot & Pucheran.

The genus contains a single species, *B. capellei*.

Butreron capellei (Temminck).

(The Large Thick-billed Green Pigeon.)

1823. *Columba capellei*, Temminck, *Pl. Color d'Oiseaux* IV, livr. 24, p. 223, pl. 143. (Java.)
1849. *Treron capellei*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 228, No. 1382.
1928. *Butreron capellei*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 197.
1937. *Butreron capellei*, Peters, *Check-list Birds World* III, p. 13.

Butreron capellei is represented in the collection of the Indian Museum by the following skins :

Reg. No	Sex.	Locality	Date	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
12918	♀	Pilai (Mergui, S. Burma).	Mar 13, 1882	Dr. J. Anderson (Mergui Exped.)	203	(109)	33	(22)
17095	♂	Perak (Malay Penin.).	(?)	"Mus. Coll."	193	140	27	21
17906	♀	Perak (Malay Penin.).	(?)	"Mus. Coll."	198	129	31	20
26458	♂	Malacca (Malay Penin.)	1841	Rev. F. W. Lindstedt (Asiat. Soc Bengal).	196	126	32	22
26459	♂	Malacca (Malay Penin.).	1841	Rev. F. W. Lindstedt (Asiat. Soc. Bengal).	191	125	30	22
13151	(Juv.)	Malacca (Malay Penin.).	(?)	Bengal Economic Mus.	186	..	30	20

Remarks. Nos. 26458 and 26459 were listed by Blyth (1849, p. 229. No. 1382, *A*, *B*). No. 13151 is unsexed ; it is smaller than the others and its breast is golden yellowish-green ; it appears to be a juvenile.

Distribution. "Malay Peninsula, Sumatra, Java and Borneo" (Peters).

Stuart Baker (1928, p. 199) remarked that it was once obtained by Dr. Anderson in Elphinstone Is. off the Mergui coast. I presume that this bird is the Indian Museum skin (No. 12918, ♀) from Pilai, Mergui, and was possibly a straggler. It is not known to breed within the Indian limits.

Some authors recognise various subspecies of *B. capellei*, but Peters does not admit them.

Genus **Sphenurus** Swainson[1].

Sphenurus apicauda (Blyth).

The species extends from the Himalayan foot-hills of Kumaun (U. P., India) in the west, *via* Assam, Burma (including Tenasserim) and Siam(?) to Indo-China. It does not occur, except perhaps as a straggler, in the Malay Peninsula. Of the three subspecies recognised by Peters (1937, p. 11), only *S. a. apicauda*, occurs within the Indian limits.

Sphenurus apicauda apicauda (Blyth).

(The Pin tailed Green Pigeon.)

1845 (after May 1846). *Treron apicauda* "Hodgson" Blyth, *Journ. Asiat. Soc. Bengal* XIV, p. 845. (Southeastern Himalayas and hill ranges of Assam ; common at Darjeeling.)

1849. *Treron (Sphenocercus) apicauda*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 230, No. 1392.

1928. *Sphenocercus apicaudus apicaudus*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 199.

1937. *Sphenurus apicauda apicauda*, Peters, *Check-list Birds World* III, p. 11.

[1] *Sphenurus* Swainson 1837 replaces *Sphenocercus* G. R. Gray 1840.

Sphenurus apicauda apicauda is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
3920	(♀?)	Kurseong, 2,000 ft. (Sikkim).	May 19, 1870	Capt. H. J. Elwes.	159	160	29	20
26457	(♀?)	Darjeeling (N. Bengal).	1845	Mr. Webb (Asiat. Soc. Bengal).	165	..	23	16·5
26539	♀	Hsimara Duars, 500 ft. (N. Bengal).	Mar. 7, 1927	Mr. C. M. Inglis.	161	171	26	19
26540	♂	Rahti Forest (Jalpaiguri Dist., N. Bengal).	Feb. 27, 1937	Mr. C. M. Inglis.	170	190	21	21
26343	♂	Chonglionsen (Naga Hills, Assam).	Mar. 3, 1935	Zool. Survey of India.	161	231	21	20
26455	(♂?)	(?)	(?)	Asiat. Soc. Bengal.	168	203	26	19
26456	(♂?)	(?)	(?)	Asiat. Soc. Bengal.	166	223	29	18

Remarks.—No. 26457 was listed by Blyth (1849, p. 230, No. 1392 *B.*)

Distribution.—"Himalayan foothills up to 6000 feet from Kumaun to eastern Assam and southward to Tenasserim" (Peters).

Stuart Baker (1928, p. 200; 1935, p. 135) gave the following additional range: Goes up to at least 8,000 feet; found as a straggler in the plains of Bihar and Bengal; a solitary but rather doubtful instance from Perak in northern Malaya.

Sphenurus sphenurus (Gould).

The species ranges along the Himalayan foothills from Kashmir in the west, *via* Assam to Yunnan and northern Tonkin, and Annam (Indo-China) to the Island of Hainan; also in the mountains in the main range of the Malay Peninsula. Peters (1937, p.12) admits five subspecies of which only *S. s. sphenurus* occurs within the Indian limits.

Sphenurus sphenurus sphenurus (Gould).

(The Wedge-tailed Green Pigeon.)

1831. *Vinago sphenura,* Gould, *Century of Birds,* pl. 57. (Himalayas.)
1831. *Vinago sphenura,* Gould, *Birds hitherto unfigured from the Himalaya Mts.,* pl. 40. (Himalayas.)
1849. *Treron (Sphenocercus) cantillans,* Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal,* p. 230, No. 1391.
1928. *Sphenocercus sphenurus sphenurus,* Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 200.
1937. *Sphenurus sphenurus sphenurus,* Peters, *Check-list Bird World* III, p. 12.

Sphenurus sphenurus sphenurus is represented in the collection of the Indian Museum by the following skins :

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
26453	(♂)	"Murri" (?Murree, Rawalpindi Dist., N. Punjab).	June 30, 1873	Dr. F. Stoliczka (Yarkand Exped.).	178	139	23	18
26454	(Juv.)	"Murri" (=?Murree, Rawalpindi Dist., N. Punjab).	July 2, 1873	Dr. F. Stoliczka (Yarkand Exped.).	[168	106	25	..]
4331	♂	Katmandu (Nepal).	(?)	"Mus. Coll."	175	135	24	10
3926	♂	Darjeeling (N. Bengal).	(?)	Dr. J. Anderson.	180	142	26	20
3927	(Juv.)	Darjeeling (N. Bengal).	(?)	Dr. J. Anderson.	[180	133	23	..]
3928	♀	Darjeeling (N. Bengal).	Nov. 1871	(Mr. Donett ?)	171	122	27	17
23222	♀	"Loisampa" Loi-San-Pa, 600 ft. (S. Shan States).	Jan. 1, 1900	Col. C. T. Bingham.	166	98	25	12

Remarks. In the Indian Museum there is a poorly preserved skin labelled: "Type No. 1391, *Sphenocercus cantillans* Blyth. Upper Provinces ? Purchased. A. S. B." This appears to be the bird described by Blyth (1843, p. 166) as *Vinago cantillans* (Cape variety), and subsequently by the same author (1849, p. 230, No. 1391 *D*) as *Sphenocercus cantillans*. The Indian Museum specimen resembles *Sphenurus sphenurus sphenurus* in structural characters but is very different in coloration. The green, orange and yellow of the normal bird is here completely replaced by dark grey; the fore-head is pink-rufous and the fore-breast pinkish grey; the upper back, scapulars and lesser wing coverts are maroon as in the male of *S. s. sphenurus*. Salvadori (1893, p. 10) regarded it as a separate variety, *cantillans*, and recorded two specimens in the British Museum one adult ♂ collected by A. Grote (no locality) in the Gould Coll., and another adult ♀ collected by B. M. Hodgson from Nepal. Jerdon (1864, p. 453) had stated that "after moulting in confinement, the green colour, in some specimens, becomes pale maronne". This statement was repeated by Blanford (1898, p. 17), but lacks further confirmation.

Distribution. "Mountains between 2000 and 8000 feet from Kashmir to Assam and the Shan States, south to Tenasserim" (Peters).

Subfamily *Duculinae*.

Genus **Ducula** Hodgson[1].

Ducula badia (Raffles).

The species ranges from India and Burma to Yunnan, Siam and Indo-China, and *via* the Malay Peninsula to Sumatra, Java and Borneo.

[1] I have used the name *Ducula* in the restricted sense of Hodgson (*Asiat. Res.* XIX, p. 160, 1836) as accepted by Stuart Baker (1928, p. 202). It is partly equivalent to *Carpophaga* Selby. Peters (1937, pp. 42-54) uses *Ducula* Hodg. in the extended sense so as to include in it nine genera including *Carpophaga* Selby and *Myristicivora* Reichenbach.

Peters (1937, p. 51) specifically separates *D. lacernulata* (Temminck) (Java, Lombok and Flores) from *D. badia*, but Chasen (1935, p. 19) regards the two groups as conspecific under *badia*.

Ducula badia badia (Raffles).

(The Malay Imperial Pigeon or Mountain Imperial Pigeon.)

1822. *Columba badia*, Raffles, *Trans. Linn. Soc. Lond.* XIII, p. 317. (Sumatra Benkulen, W. Sumatra.)
1928. *Ducula badia badia*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 202.
1937. *Ducula badia badia*, Peters, *Check-list Birds World* III, p. 51.

Ducula badia badia is represented in the collection of the Indian Museum by the following skin :

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl	Tr.	C.
26551	♂	Bought alive in Bagan Datok Market, Perak (Malay Penin.).	Jan. 18, 1915	Raffles Mus., Singapore.	239	190	32	22

Distribution.—" Southern Tenasserim southward over the Malay Peninsula ; islands off the Mergui coast ; Sumatra ; Borneo " (Peters). Certain records from Yunnan proved later to be erroneous.

Ducula badia insignis Hodgson.

(Hodgson's Imperial Pigeon.)

1836. *Ducula insignis*, Hodgson, *Asiat. Res.* XIX, p. 162, pl. 9 (head and foot). (Nepal.)
1849. *Carpophaga insignis* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 232, No. 1404.
1913. *Ducula insignis insignis*, Stuart Baker, *Rec. Ind. Mus.* VIII, pp. 286, 287. (*a* only ; *b* from Kobo is wrongly identified as *Ducula* ; it is really *Alsocomus puniceus* Blyth.)
1928. *Ducula badia insignis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 203.
1937. *Ducula badia insignis*, Peters, *Check list Birds World* III, p. 51.

Ducula badia insignis is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
26167	♀	Darjeeling (N. Bengal).	1849	Asiat. Soc. Bengal.	233	185	31	20
3970	♀	Darjeeling (N. Bengal).	1870	Capt. H. J. Elwes.	240	197	28	23
26513	♂	Jalpaiguri Dist. (N. Bengal).	Jan. 26, 1940	Mr. C. M. Inglis.	241	196	32	22·5
26514	♀	Hasimari (Jalpaiguri Dist., N. Bengal).	Jan. 25, 1940	Mr. C. M. Inglis.	240	187	31	23
25372	(?)	Pasighat, 600 ft. (N. E. Assam).	1912	Dr. S. W. Kemp (Abor Exped.).	252	197	29	25

Remarks. No. 26167 was recorded by Blyth (1849, p. 232, No. 1401 *B*).

Distribution. " Western Nepal, Sikkim and Bhutan, east to Khasia Hills and the Brahmapootra River " (Peters).

Ducula badia griseicapilla Walden.

(The Grey-headed Imperial Pigeon.)

1849. *Carpophaga insignis* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 232, No. 1401.

1875. *Ducula griseicapilla*, Walden, *Ann. Mag. Nat. Hist.* (4) XVI, p. 228. (Karen Hills between 1,000 and 1,200 feet, Burma).

1928. *Ducula badia griseicapilla*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 204.

1937. *Ducula badia griseicapilla*, Peters, *Check-list Birds World* III, p. 51.

Ducula badia griseicapilla is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.)			
					W.	Tl.	Tr.	C.
26166	♂	63 miles west of Imphal (Manipur State, Assam).	Feb. 13, 1936	Zool. Survey of India.	241	[illegible]	31	[illegible]
23220	♂	" Loisampa " Loi-San-Pa (Shan States).	Dec. 30, 1899	Col. C. T. Bingham	[illegible]	[illegible]	[illegible]	[illegible]

Distribution. " Burma and southwestern Yunnan to northern Tenasserim, Siam and all Indochina " (Peters).

Stuart Baker (1928, pp. 204, 205) also includes within its range the whole of Assam (except the hill ranges of Brahmaputra River and the Khasia Hills where *insignis* occurs). He says that the birds from Cachar, Sylhet, Manipur and the Bengal districts east of the Bay, though somewhat intermediate between *insignis* and *griseicapilla* are nearest to the latter.

Ducula badia cuprea (Jerdon).

(Jerdon's Imperial Pigeon.)

1840. *Carpophaga cuprea*[1], Jerdon, *Madras Journ. Lit. & Sci.* XII, p. 12. (Wynaad, Malabar, S. India.)

1928. *Ducula badia cuprea*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 205.

1937. *Ducula badia cuprea*, Peters, *Check-list Birds World* III, p. 51.

Ducula badia cuprea is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.)			
					W.	Tl.	Tr.	C.
18456	♂	Madathuray (Travancore).	(?)	" Mus. Coll. Jaffa."	223	173	29	23
18457	♀	Madathuray (Travancore).	(?)	" Mus. Coll. Jaffa."	223	171	31	24
23002	(?)	Palode (N. or S. Travancore).	1870	Trivandrum Mus.	235	(171)	31	24
18606	♀	N. Bangalore (Mysore State).	(?)	" Mus. Coll. Jaffa."	225	175	31	(24)

[1] Not *Columba cuprea* as wrongly given by some authors including Stuart Baker (1928, p. 205).

Distribution.—"Southwestern India from Kanara, southward" (Peters). Once (?) recorded from Ceylon[1].

Genus **Muscadivora** Schlegel[2].

Muscadivora aenea (Linnaeus).

The species ranges from India, Ceylon, the Andaman and Nicobar Islands and the Indo-Burmese countries (including Burma, Siam, French Indo-China, the Malay Peninsula) to the Malayasian Islands (Java, Sumatra, Borneo and Celebes), and thence east to the Philippines and the Flores, and Lombock and Sulu Islands. Peters (1937, pp. 46, 47) admits thirteen subspecies of which four occur within the Indian limits.

Muscadivora aenea aenea (Linnaeus).

(The Malay Green Imperial Pigeon.)

1766. *Columba aenea*, Linnaeus, *Syst. Nat.* (12th ed.) I, p. 283. ("In Moluccas", *errore*=Flores Is., Dutch East Indies, *vide* Hartert & Goodson, *Novit. Zool.* XXV, p. 346, 1918.)
1849. *Carpophaga sylvatica* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 231, No. 1401.
1928. *Muscadivora aenea aenea*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 207.
1937. *Ducula aenea aenea*, Peters, *Check-list Birds World* III, p. 46.

Muscadivora aenea aenea is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
26555	♀	Juara Bay, Pulau Tioman, S. China Sea.	June 9, 1906	Raffles Mus., Singapore.	226	157	31	21
26337 (Mounted in gallery.)	♀	(?)	May 11, 1935	Zool. Gardens, Calcutta.	(220)	147	..	25

Distribution.—"Southern Tenasserim and southern Siam, southward over the Malay Peninsula; Rhio Archipelago, Sumatra, Java, Banka, Borneo; Anamba, Natuna and Tambelan Islands; Lombok, Sumbawa, Sumba, Flores, Panter and Alor; Sulu Archipelago" (Peters).

Its Indian distribution "Southern Tenasserim" needs some comments. Stuart Baker (1928, p. 208) remarked that "Tenasserim specimens, as in so many species of birds, are somewhat intermediate but the southernmost seem distinctly referable to this race". In the Indian Museum there are a few skins (p. 313) from Taing and Pilai in the Mergui area which are referable to race *sylvatica* (not *aenea*), so that *aenea* probably occurs only farther south than Taing and Pilai.

[1] The only record is that given by Stuart Baker (1913, p. 107) who says that J. Stewart obtained this bird, together with an egg (taken in October) at Ratnapura in Ceylon. Later (1935, p. 139) he refers evidently this same specimen to Inglis, and in this he appears to be wrong. Phillips (1941, p. 205) says that it was "recorded only once, from the Sabaragamuwa jungles"—this is probably the same record as that given by Stuart Baker.

[2] Stuart Baker (1928, p. 206) wrongly assigns this genus to Selby (*Nat. Libr., Pigeons*, p. 112, 1835) who is the author of *Carpophaga*. *Carpophaga* Selby=*Muscadivora* Schlegel (see Salvadori, 1893, p. 181).

Muscadivora aenea sylvatica (Tickell).

(The Indian Green Imperial Pigeon.)

1833. *Columba Sylvatica*, Tickell, *Journ. Asiat. Soc. Bengal* II, p. 581. (Jungles of Borobhum and Dholbhum, Bihar.)
1849. *Carpophaga sylvatica* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 231, No. 1401.
1928. *Muscadivora aenea sylvatica*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 208.
1937. *Ducula aenea sylvatica*, Peters, *Check-list Birds World* III, p. 46.

Muscadivora aenea sylvatica is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
3963	♀	Daminiok (Bihar ?).	(?)	Mr. V. Ball.	235	162	27	23
3965	♂	Rajmahl Hills (E. Bihar).	(?)	Mr. V. Ball.	240	160	31	20
5730	(?)	Lamagooting (Assam).	(?)	Capt. Butler.	230	153	34	26
5731	(?)	Lamagooting (Assam).	(?)	Capt. Butler.	240	156	40	22
5732	(?)	Lamagooting (Assam)	(?)	" Mus. Coll."	239	160	29	23
3961	(?)	Cachar (Assam). ..	(?)	" Mus. Coll."	234	155	35	23
3966	(?)	Cachar (Assam). ..	(?)	" Mus. Coll."	245	163	30	21
6951	(?)	Naga Hills (Assam). ..	(?)	Capt. Butler.	240	169	34	(23)
6952	(?)	Naga Hills (Assam). ..	(?)	Capt. Butler.	245	166	42	26
13325	♀	Jergo Is. (off Arakan Coast, W. Burma).	Mar. 1881	Marine Survey of India.	232	155	31	25
9016	♂	Poodeeppoo (Upper Burma).	1875	Dr. J. Anderson.	245	160	20	25·5
5732	(?)	Burma.	(?)	" Mus. Coll."	234	153	31	23
5733	♀	Burma.	(?)	Capt. Butler.	232	153	28	23·5
12913	(?)	Taing (Mergui, S. Burma).	Jan. 31, 1882	Dr. J. Anderson (Mergui Exped.).	245	(170)	31	(23)
12912	(?)	Taing (Mergui, S. Burma).	Jan. 31, 1882	Dr. J. Anderson (Mergui Exped.).	232	154	31	24
12909	♂	Pilai (Mergui, S. Burma).	Mar. 9, 1882	Dr. J. Anderson (Mergui Exped.).	231	160	33	22
12910	♀	Pilai (Mergui, S. Burma).	Mar. 9, 1882	Dr. J. Anderson (Mergui Exped.).	233	166	28	24
12911	♂	Pilai (Mergui, S. Burma).	Mar. 13, 1882	Dr. J. Anderson (Mergui Exped.).	230	156	33	23
3967	(?)	Andamans. ..	(?)	Dr. G. E. Dobson.	232	(153)	30	22
3968	(?)	Andamans. ..	(?)	Dr. G. E. Dobson.	241	165	31	24
3969	(?)	Andamans. ..	(?)	Dr. G. E. Dobson.	232	(162)	32	23
26468	♀	Anikhet (Port Blair, S. Andamans).	Feb. 28, 1890	Dr. G. H. Bailey.	232	148	30	24

Remarks.—Stuart Baker (1928, p. 208) states that the " Andaman birds are very green and average more white on the forehead and face but seem hardly separable from *sylvatica* ". The few skins from the Andamans in the Indian Museum support these remarks.

In the Indian Museum specimens no difference in measurement is discernible between birds from Eastern India, Burma and the Andamans.

Distribution.- " Nepal, Sikkim Terai and Assam, south to about lat. 20° N. in the Indian Peninsula, central Tenasserim, northern Siam and all of Indochina ; Andaman Islands[1] : Pulo Condor, Hainan (?)" (Peters).

Muscadivora aenea pusilla (Blyth).

(The South Indian Green Imperial Pigeon.)

1849. *Carpophaga pusilla*, Blyth, *Journ. Asiat. Soc. Bengal* XVIII, Pt. 2, p. 816. (Nilgiris, *errore*=South India, *vide infra*.)
1849. *Carpophaga pusilla*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 232, No. 1402.
1928. *Muscadivora aenea pusilla*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 209.
1937. *Ducula aenea pusilla*, Peters, *Check-list Birds World* III, p. 46.

Muscadivora aenea pusilla is represented in the collection of the Indian Museum by the following skins :--

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Ts.	C.
18455	♂	" Mudthary " (Travancore).	(?)	" Mus. Coll."	217	150	30	21
26469 (Holotype).	(?)	" Nilgiris " (*errore*) (= S. India).	1845	Dr. T. C. Jerdon.	210	(138)	28	20
26470 (Syntype).	(?)	" Nilgiris " (*errore*) (=S. India).	1845	Dr J. C. Jerdon.	202	112	30	(22)
26548	♂	Katupathawwa (North Central Prov., Ceylon). [*Dry Zone.*]	Sept. 11, 1919.	Colombo Mus., Ceylon.	215	160	30	19
26547	♀	Higara or Hujara (South Prov., Ceylon). [*Wet Zone.*]	May 18, 1932.	Colombo Mus., Ceylon.	213	151	(32)	21

Remarks.—Blyth (1849*a*, p. 816) wrote about the bird as follows :— " No. 1402 *C. pusilla*, nobis. Like *C. sylvatica* (vel *aenea* of India), but much smaller, and nape very rufescent. Length of wing 8¼ in. ; of tail 5½ in. Nilgiris." No other particulars were given. In his *Catalogue* (1849, p. 232) he wrote : " 1402 *C. pusilla*, Blyth, J. A. S. XVIII, HAB. Nilgiris. *A*. Specimen presented by T. C. Jerdon, Esqr. (1845)."

In the Indian Museum, however, there are two skins, Nos. 26469 and 26470, which bear identical labels as follows :—" Type No. 1402, *Carpophaga pusilla* Blyth. Nilgiris. T. C. Jerdon, Esqr., 1845, A. S. B." No doubt, one of these two skins is the specimen listed in Blyth's

[1] " The Andaman birds possibly represent a distinct race " (Peters).

Catalogue. Of the two, No. 26469 agrees with Blyth's *Journ. Asiat. Soc. Bengal* specimen in measurements (wing $8\frac{1}{4}''$=about 210 mm.; tail $5\frac{1}{2}''$=about 138 mm.) and also in having the nape rupescent. It must therefore be regarded as the Holotype. No. 26470 then becomes a Syntype.

Type-locality. Referring to this bird as *Carpophaga sylvatica*, Jerdon (1864, p. 456) showed that Blyth was wrong in accepting Nilgiris as the type-locality. Jerdon wrote: "... I do not consider Blyth's small race *C. pusilla*, from the South of India, distinct from the bird of Central India ...; ... the supposed new species was founded on a peculiarly small specimen." And further: "...Mr. Blyth was mistaken when he stated that the specimen sent him by myself, from which he made his *pusilla*, was from the Neilgherries [old spelling of Nilgiris]; indeed I have not even seen this pigeon in the Wynaad."

Blyth's type, therefore, did not come from the Nilgiris, but from some other place in "South of India". The type-locality should, therefore, be South India. (Stuart Baker, 1928, p. 209, gives the type-locality as Ceylon, but without authority.)

Distribution.—"Indian Peninsula from about lat. 20°N., southward; Ceylon" (Peters).

Genus **Myristicivora** Reichenbach.

Myristicivora bicolor (Scopoli).

(The Pied Imperial Pigeon.)

1786. *Columba bicolor*, Scopoli, *Delic. Flora et Faunae Insubr.*, fasc. 2, p. 94. (New Guinea.)
1849. *Carpophaga bicolor*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 232, No. 1406.
1928. *Myristicivora bicolor bicolor*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 211.
1937. *Ducula bicolor*, Peters, *Check-list Birds World* III, p. 50.

Some authors have recognised several races of this species, but they are not admitted by Peters (1937, p. 50).

Myristicivora bicolor is represented in the collection of the Indian Museum by the following skins:-

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm).			
					W.	Tl.	Tr.	C.
18347	♀	Andamans.	(?)	G. H. Booley	(220)	..	33	25
3072	(?)	Nicobars. . ..	(?)	(?)	221	137	32	24
3073	(?)	Nicobars.	(?)	(?)	207	110	31	22
26566	♂	Pulau Jarak, Straits of Malacca (Malaya).	April 8, 1915.	Raffles Mus., Singapore.	225	123	31	23
10806	♀	New Guinea.	June 1877	Jardin des Plantes (Paris ?).	224	112	32	23
26822	♀	(?)	1901	Zool. Gardens, Calcutta.	247	143	35	23

Remarks.—No. 18347 is a poorly preserved specimen with the plumage soiled with fat; the tail and wings are damaged; the under tail-covert have a few irregular black spots at the base. In Nos. 3972 and 3973 the under tail-coverts are pure white with no black spots.

Distribution.—" Recorded from many localities between the Bay of Bengal and the Philippines, eastward to the Aru Islands and islands west of New Guinea. Occurs chiefly on smaller islands and islets, wandering in large flocks from island to island in search of food " (Peters).

There is a skin, No. 10806, in the Indian Museum merely labelled " New Guinea ".

Family COLUMBIDAE.

Subfamily *COLUMBINAE*.

Genus **Columba** Linnaeus[1].

Columba livia Gmelin.

The species ranges from the British Isles and W. Europe, *via* N. Africa and W. Aisa to India, and N. China (?). Peters (1937, pp. 58-60) admits fourteen subspecies of which two, *neglecta* and *intermedia*, occur with certainty within the Indian limits, while about the occurrence of a third, *livia*, opinion is divided—most probably it does not occur within the Indian limits.

Columba livia neglecta Hume.

(Hume's Blue Rock Pigeon.)

1873. *Columba neglecta*, Hume, *Lahore to Yarkand* (by Henderson & Hume), p. 272. (Ladak, Kashmir.)
1928. *Columba livia neglecta*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 220.
1937. *Columba livia neglecta*, Peters, *Check-list Birds World* III, p. 59.

Columba livia neglecta is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
9931	♀	West of Bām (E. Iran).	April 26, 1872	Mr. W. T. Blanford.	219	130	29	19
24850	♀	Kuhak (Seistan, E. Iran).	April 22, 1905	J. W. N. Cumming.	218	121	30	19
25463	(?)	Lab-i-Baring, 1,600 ft. (Seistan, E. Iran).	March 11, 1919	Drs. N. Annandale & S. W. Kemp.	230	136	31	19

[1] *Columba*, Linnaeus, *Syst. Nat.* (10th ed.) I, p. 162, 1758. Type (by subsequent designation of Vigors, 1825) is *Columba oeneas*, Linnaeus (*loc. cit.*). Stuart Baker (1928, pp. 218, 219), following Mathews (1927, p. 55), regards as the type *Columba palumbus* Selby (*Ill. Brit. Orn.* I, p. xxx, 1825). He gives Selby's date first (p. 218) as 1852 and then (p. 219) as 1925, both wrong, as Ticehurst pointed out in 1930. Both Hartert (1920) and Peters (1937) give priority to Vigors 1825 over Selby 1825, and I follow them.

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
21879	♂	Shorawak (S. Afghanistan).	(?)	Dr. F. R. Maynard.	231	126	(32)	19
22838	(?)	(Kashmir or Yarkand region ?).	Aug. 11, 1873	Capt. Trotter (Forsyth's Yarkand Exped., 1873-74).	216	127	30	19
22836	♀	(Kashmir or Yarkand region ?).	Aug. 20, 1873	Dr. F. Stoliczka (Forsyth's Yarkand Exped., 1873-74).	222	129	31	21
6059	♂	Kharbu (Kurbu or Karbu) (Ladak, Kashmir).	June 26, 1870	Dr. G. Henderson.	227	135	32	20
22835	(?)	Kharbu (Kurbu or Karbu) (Ladak, Kashmir).	Aug. 21, 1873	Dr. F. Stoliczka.	222	135	32	21
17268	♂	Shergul (Kashmir).	Sept. 25, 1875	Dr. J. Scully.	235	120	(30)	18
17269	♀	Shergul (Kashmir).	Sept. 25, 1875	Dr. J. Scully.	231	..	31	21
22837	(?)	Nurla (Kashmir).	Aug. 28, 1873	Dr. F. Stoliczka.	225	125	31	21
7063	♀	Gilgit, 5,000 ft. (Kashmir).	July 1876	J. Biddulph.	212	116	29	19
17276	♂	Gilgit (Kashmir).	Nov. 10, 1878	Dr. J. Scully.	227	125	30	21
17279	♀	Gilgit (Kashmir).	Jan. 12, 1879	Dr. J. Scully.	215	120	29	18
17277	♂	Gilgit (Kashmir).	March 9, 1879	Dr. J. Scully.	222	128	31	21
17278	♂	Gilgit (Kashmir).	May 21, 1879	Dr. J. Scully.	230	128	33	20
22839	♂	Gilgit (Kashmir).	Jan. 16, 1880	Dr. J. Scully.	..	123	20	20
6007	(?)	Dras (Kashmir).	June 23, 1870	Dr. G. Henderson.	211	112	27	19

Remarks.—The specimens of *neglecta* in the Indian Museum are in some respects, especially the colour of the rump, intermediate between *livia* and *intermedia*. As pointed out by Ticehurst (1923, p. 463), in *neglecta* the rump is in most cases either very pale grey or white. But the lighter patch is considerably narrower than in *livia*. In a few cases, as in Nos. 7963 (Gilgit), 17269 (Shergul), 22835 (Kharbu), 22838 (Kashmir or Yarkand ?) and 21879 (Shorawak, S. Afghanistan), the rump is grey almost as in *intermedia* from which it is difficult to distinguish these individuals. However, other specimens from the same regions correspond to true *neglecta*.

Distribution.—" Transcaspia and Turkestan south to southern Persia, Baluchistan, Sind and northwestern Punjab " (Peters).

There is a specimen, No. 21879, in the Indian Museum from Shorawak in S. Afghanistan which is *neglecta*. (From N. E. Afghanistan, Meinertzhagen, 1938, p. 707, has recently recorded *C. l. gaddi*.)

Columba livia intermedia Strickland.

(The Indian Blue Rock Pigeon.)

1844. *Columba intermedia*, Strickland, *Ann. Mag. Nat. Hist.* XIII, p. 39 (India-Calcutta.)
1849. *Columba (Columba) livia* (part, variety in S. Asia), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, pp. 233, 234, No. 1417, *C* to *H*.
1928. *Columba livia intermedia*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 221.
1937. *Columba livia intermedia*, Peters, *Check-list Birds World* III, p. 59.

Columba livia intermedia is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor	Measurements (mm).			
					W.	Tl.	Tr.	C.
26515	(?)	"Upper Burma". ..	1863	Col. Phayre.	215	122	30	18
26516	(?)	"Upper Burma". ..	1863	Col. Phayre.	216	120	30	18
26517	(?)	Burma.	(?)	Dr. C. Williams.	219	117	33	..
26518	(?)	India.	(?)	Asiat. Soc. Bengal.	220	(135)	29	19
26519	(?)	Lower Bengal. ..	1843	Asiat. Soc. Bengal.	228	129	31	19
4000	(♀?)	Barrackpore (24-Parganas, Bengal).	Feb. 1870	Asiat. Soc. Bengal (Purchased).	218	(132)	32	20
4001	(♀?)	Barrackpore (24-Parganas, Bengal).	Feb. 1870	Asiat. Soc. Bengal. (Purchased).	226	..	29	20
17270	(?)	Katmandu (Nepal)	April 10, 1877	Dr. J. Scully.	204	116	29	..
17271	(?)	Katmandu (Nepal)	April 10, 1877	Dr. J. Scully.	218	138	30	18·5
17272	(?)	Katmandu (Nepal)	April 29, 1877	Dr. J. Scully.	213	121	27	20
17273	(?)	Balaji (Nepal). ..	May 15, 1877	Dr. J. Scully.	207	117	31	18
17275	(?)	Near Balaji (Nepal).	Nov. 25, 1877	Dr. J. Scully.	223	136	31	..
17274	♂	Harigaon (Nepal). ..	Sept. 17, 1877	Dr. J. Scully.	215	136	36	..
3999	(?)	Simla (Punjab). ..	(?)	Dr. F. Stoliczka.	231	124	30	20
3997	♂	Agra (U. P.). ..	Nov. 1867	"Riddell Mus."	213	125	31	21
3994	♀	Agra (U. P.). ..	Nov. 1869	"Riddell Mus."	212	130	31	22
26568	(?)	"Masuri" =? Mussooree (U. P.).	1849	Capt. Hutton.	(231)	133	..	21
3995	♂	Chota Nagpur. ..	Dec. 1868	Mr. V. Ball.	226	(125)	31	20
3996	(?)	Daminiok (Bihar ?).	May 31, 1870	Mr. V. Ball.	210	118	28	18
3998	♂	Singhbhum (Bihar).	April 16, 1869	Mr. V. Ball.	220	123	33	19
10761	♂	Palamau (Bihar).	April 6, 1878	Mr. V. Ball.	212	118	30	19
11456	♂	"Bhoura" (=Bavda), 2,500 ft. (Kolhapur State, Bombay Pres.).	April 19, 1878	Surg. J. Armstrong.	217	120	31	20
23950	♂	Trivandrum (Travancore).	Nov. 1891	Trivandrum Mus.	206	..	30	20

Remarks.- Nos. 22351, ♀, 21950, ♂, and 23712 are ornamental breeds mounted in the gallery ; they are not listed in the above table.

No. 26517 (" Burma ") and No. 26518 (" India ") have a dark, almost black, upper plumage ; and No. 3996 (Daminiok, ?Bihar) is speckled with black on the back and wings. These three specimens are evidently domesticated varieties.

With the exception of some of the skins discussed above, all the other skins in the Indian Museum, including the two skins from " Upper Burma ", Nos. 26515 and 26516, have the plumage typical of wild birds.

Hartert (1920, p. 1170) was of the opinion that the darkest and the most typical forms are found in S. India. The two S. Indian specimens, Nos. 11456 and 23950, in the Indian Museum are not appreciably darker than the N. Indian birds.

Distribution. " All of India (except the part occupied by *neglecta*) east to western Assam and south to the dry parts of Burma ; Ceylon ; occurrence in Siam may be due to introduction " (Peters).

Columba rupestris Pallas.

1827. *Columba Oenas* δ *rupestris*, Pallas, *Zoogr. Russo-Asiat.* I, p. 560. (Dauria, Transbaikalia.)

The species ranges from practically the whole of Asiatic Russia below the Arctic Circle down to Kashmir, Tibet and S. China in the south, and Manchukuo and Korea in the north-east. Peters (1937, p. 57) admits two subspecies of which one occurs within the Indian limits.

Columba rupestris turkestanica Buturlin.

(The Turkestan Hill Pigeon.)

1893. *Columba rupestris pallida* (not *Columba pallida* Latham), Rothschild & Hartert, *Orn. Monatsb.* I, p. 41. (Altai Mts., Mongolia ; type from Katon Karagai.) Name preoccupied.

1908. *Columba rupestris turkestanica*, Buturlin, *Orn Monatsb.* XVI, p. 45. (New name for *Columba rupestris pallida* Roth. & Hart.)

1928. *Columba rupestris turkestanica*, Stuart Baker, *Faun. Brit. Ind.. Birds* (2nd ed.) V, p. 222.

1937 *Columba rupestris turkestanica*, Peters, *Check-list Birds World* III, p. 57.

Columba rupestris turkestanica is represented in the collection of the Indian Museum by the following skins :—

(*a*) *Juveniles.*

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
21501	♂ (Juv.)	Little Pamir (E. Turkestan).	(?)	Dr. Alcock.	[205	124	27	19]
21502	♂ (Juv.)	Little Pamir (E. Turkestan).	(?)	Dr. Alcock.	[199	116	28	21]
21503	♀ (Juv.)	Little Pamir (E. Turkestan).	(?)	Dr. Alcock.	[200	118	27	20]
13289	♂ (Juv.)	Kilian Valley (E. Turkestan).	July 11, 1883	C. Ellis.	[223	115	26	18]

(*b*) *Adults.*

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
17282	♂	Gilgit (Kashmir).	Dec. 7, 1879	Dr. J. Scully.	228	123	29	17
17283	♂	Gilgit (Kashmir).	Dec. 7, 1879	Dr. J. Scully.	240	140	33	17
17284	♀	Gilgit (Kashmir).	Nov. 8, 1879	Dr. J. Scully.	230	122	28	17
17280	♀	Gilgit (Kashmir).	Dec. 6, 1879	Dr. J. Scully.	228	144	29	16
13288	(?)	Tutigalak, 14,000 ft. (Ladak, Kashmir).	May 25, 1883	C. Ellis.	225	116	28	..
13268	(?)	Tutigalak, 14,000 ft. (Ladak, Kashmir).	May 25, 1883	C. Ellis.	235	135	29	16
22843	(?)	Leh (Ladak, Kashmir)	Sept. 4, 1873	Dr. F. Stoliczka.	240	136	30	16
22847	(?)	Tank(t)se (Ladak, Kashmir).	Sept. 16, 1873	Dr. F. Stoliczka.	220	143	29	15
22848	(?)	Lu(c)kung or Lughung, (Ladak, Kashmir).	Sept. 19, 1873	Dr. F. Stoliczka.	222	135	31	16
22842	(?)	Lu(c)kung or Lughung (Ladak, Kashmir).	Sept. 19, 1873	Dr. F. Stoliczka.	210	131	30	17
22846	(?)	Above Sakti (Ladak, Kashmir).	Sept. 14, 1873	Dr. F. Stoliczka.	220	127	28	14
22849	(?)	Above Sakti, 14,000 ft. (Ladak, Kashmir).	Sept. 14, 1873	Dr. F. Stoliczka.	227	138	28	14
22845	(?)	Above Sakti, 14,000 ft. ((Ladak, Kashmir).	Sept. 14, 1873	Dr. F. Stoliczka.	234	120	30	17
22844	(?)	Above Sakti, 15,000 ft. (Ladak, Kashmir).	Sept. 14, 1873	Dr. F. Stoliczka.	215	128	28	17
17280	♂	Karakoram Pass (Kashmir).	Aug. 28, 1875	Dr. J. Scully	217	138	29	16
22853	(?)	Tangitar (E. Turkestan).	Feb. 18, 1874	Dr. F. Stoliczka.	220	129	27	16
22850	(?)	Tangitar (E. Turkestan).	Feb. 18, 1874	Dr. F. Stoliczka.	228	111	29	15·3
22852	(?)	Tangitar (E. Turkestan).	Feb. 18, 1874	Dr. F. Stoliczka.	234	144	30	14·5
22840	(?)	Tangitar (E. Turkestan).	Feb. 18, 1874	Dr. F. Stoliczka.	227	134	28	16
22841	(?)	Pasrabat (E. Turkestan).	March 26, 1874	Dr. F. Stoliczka.	235	130	30	17
22851	(?)	Pasrabat (E. Turkestan).	March 26, 1874	Dr. F. Stoliczka.	224	120	30	16·5
24046	♀	Khambajong (Tibet).	Oct. 7, 1910	Capt. H. J. Walton.	232	130	28	15
17281	♀	Ku(e)nlun Mts. (W. Tibet).	Aug. 16, 1875	Dr. J. Scully	220	141	28	(19)

Remarks.—The skins in Table (*b*) are clearly identifiable as *C. r. turkestanica* adults. The four skins in Table (*a*) differ from those in Table (*b*) in the following points:—(i) smaller size; (ii) absence of metallic sheen on the nape and foreback, these areas being dark slaty; (iii) absence of metallic gloss and of purple colour on the hind neck and the forebreast, these areas being dark grey-brown with narrow rufous-brown edgings to the feathers. The birds would thus appear to be the juveniles of *turkestanica*. They further differ from the adults in the particular noted below. Whereas in all the adult skins in Table (*b*), the first primary is subequal to the second and longer than the third, in the four skins in Table (*a*) it is not so. Three of them (Nos. 21501, 21502 and 21503) have the first primary considerably shorter than the second and third, the latter two being subequal. In the fourth,

No. 13289, the second primary is the longest, and the first and the third are subequal.

Distribution.—"Semiretchensk, Zaissan and the Russian Altai, south through Turkestan and western Tibet to Gilgit and the northern slopes of the Himalayas[1] (Peters).

Columba leuconota Vigors.

The species ranges from W. Afghanistan and S.W. Turkestan (the Pamirs, etc.), north to Kansu in W. China, east to N. E. Burma and Yunnan, and south to the northern slopes of the Himalayas, including Nepal, Sikkim and Bhutan. Peters (1937, p. 57) admits two subspecies both of which occur within the Indian limits.

Columba leuconota leuconota Vigors.

(The White-bellied or Snow Pigeon.)

1831. *Columba leuconota*, Vigors, *Proc. Comm. Zool. Soc. Lond.* Pt. 1, p. 23. (Himalayas. According to Peters, *infra*, the type was probably from Nepal. According to Hartert, 1920, p. 1473, the type probably lost, but certainly from west of Sikkim.)

1928. *Columba leuconota leuconota*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 224.

1937. *Columba leuconota leuconota*, Peters, *Check-list Birds World* III, p. 57.

Columba leuconota leuconota is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date	Collector or Donor.	Measurements (mm.)			
					W.	Tl.	Tr.	C.
22883	(?)	Tashgaon (Dras Valley, Kashmir).	Aug. 17, 1873	Dr. F. Stoliczka.	226	138	30	10
6032	♀	Dras (Kashmir).	June 23, 1870	1st Yarkand Exped.	230	130	32	17·5
17287	♀	Above Matayon (Kashmir).	Oct. 1, 1875	Dr. J. Scully.	235	145	31	20
17288	♂	Joth (Gilgit, Kashmir).	Oct. 14, 1875	Dr. J. Scully.	222	127	32	21·5
24217	(Juv.)	Dhaladhar Range, 13,000 ft. (Punjab).	Aug. 22, 1902	W. M. Craddock.	[227	138	29	22]
3993	♂	Kumaon (U. P.).	1867	"Riddell Mus."	242	142	32	10
3990	♂	Kumaon (U. P.)	(?)	Dr. F. Stoliczka.	246	(139)	29	10
3980	(?)	"Rakha in Bussahir" (Bashahr State, N. E. Punjab).	Jan. 7, 1869	Mr. A. O. Hume.	221	..	28	15
3988	♂	Sikkim 12,000 ft. ..	Sept. 23, 1870	H. J. Elwes.	230	151	28	10
3991	(?)	Lachung Valley, 11,000 ft. (E. Sikkim).	Oct. 3, 1870	Mr. W. T. Blanford.	234	..	32	18
3987	♀	Chola Range 13,000 ft. (E. Sikkim).	Aug. 25, 1870	Mr. W. T. Blanford.	230	131	31	18
22882	(?)	"Sikkim"	June 28, 1875	W. E. Brooks.	236	143	32	10
12053	♂	Bhutan.	March 6, 1876	W. Rutledge.	..	..	32	20
12052	♂	Bhutan.	March 6, 1876	W. Rutledge.	208	..	31	21·5
12054	♀	(?)	March 12, 1877	W. Rutledge.	..	..	33	20
23982	(♀, Juv ?)	(?)	(?)	Zool. Gardens, Calcutta.	[232	137	33	18]

[1] "Birds from northern Kansu are referable to this race, *vide* F. Steinbacher *in litt.*" (Peters).

Remarks.—No. 23982 has the adult plumage, but differs from the other adults in the Indian Museum in the fact that its first primary is about 35 mm. shorter than the second and third, the latter two being subequal ; in all other adults the first primary is only 5-10 mm. shorter than the second.

I am unable to distinguish Bhutan and Sikkim skins in the Indian Museum from those obtained farther west.

Distribution.—" The Himalayas from western Afghanistan to Sikkim, where it intergrades with the next form [*i.e.*, *gradaria*] ; occurs in summer in the Alai Mountains[1] and the Pamirs in southwestern Turkestan " (Peters).

Columba eversmanni Bonaparte.

(The Eastern Stock-Pigeon.)

1856. *Columba eversmanni*, Bonaparte, *C. R. Acad. Sci. Paris* XLIII, p. 838 (Western and Central Asia.)

1928. *Columba oenas eversmanni*, Stuart Baker, *Faun. Brit. Ind.*, *Birds* (2nd ed.) V, p. 226.

1937. *Columba eversmanni*, Peters, *Check-list Birds World* III, p. 61.

Columba eversmanni is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
24851	♀	Kuhak (Seistan, E. Iran).	April 28, 1905	J. W. N. Cumming.	190	107	24	18
14529	♀	Tirphul (N. W. Afghanistan).	April 23, 1885	Surg. Aitchison (Afghan Bound. Comm.)	195	108	26	18
14530	♀	Tirphul (N. W. Afghanistan).	April 22, 1885	Surg. Aitchison (Afghan Bound. Comm.).	195	108	20	19
14528	♂	Toman-Agha (N. W. Afghanistan).	April 25, 1885	Surg. Aitchison (Afghan Bound. Comm.).	200	108	27	17
14300	♂	Min Darakht (Afghanistan).	June 1, 1886	Capt. Yate (Afghan Bound. Comm.)	204	118	25	17
17293	♂	Yak Shamba Bazar (40 miles S. of Yarkand, E. Turkestan).	Aug. 1, 1875	Dr. J. Scully.	203	110	25	18
17295	♀ (Juv.)	Yak Shamba Bazar (40 miles S. of Yarkand, E. Turkestan).	Aug. 1, 1875	Dr. J. Scully.	[196	107	27	17·5]
17296	(Juv.)	Dras (Ladak, Kashmir).	Sept. 20, 1875	Dr. J. Scully.	[190	108	25	17]
6116	♂ (Juv.)	Chagrā (Ladak, Kashmir).	Oct. 8, 1870	Dr. G. Henderson.	[201	111	25	17]
3984	(?)	Sirsa District (Punjab).	(?)	Mr. A. O. Hume.	209	112	28	18
26520	(?)	Hansi (Hissar District, Punjab).	(?)	Dr. Scott (Asiat. Soc. Bengal).	202	116	(28)	18
14694	(?)	Kolassi (Purnea District, Bihar).	Jan. 14, 1886	H. Reilly.	198	99	26	20
3985	(?)	(?)	(?)	Dr. Fayrer.	190	113	27	17
3986	(?)	(?)	(?)	Dr. Fayrer.	201	104	27	16·5

[1] Stuart Baker's remark (1928, p. 224) that it breeds as far north as the Altai Mts. is probably wrong. The only records are from the Alai Mts. which lie considerably south of the Altai Mts.

Remarks.—Nos. 17295, 17296 and 6116 from Ladak appear to be juveniles. In No. 6116 the plumage is brownish instead of the grey of adults, and there is no metallic gloss on the neck and forebreast—Dr. Henderson (1873, p. 27) who obtained it had stated: "possibly a young bird". Nos. 17295 and 17296 are less brown, and the metallic gloss is partially present.

Distribution.—"Turkestan from the Aral Sea to northern Afghanistan and east to Zaissan-nor; in winter to Sind, the southern Punjab, the United Provinces and Bihar" (Peters).

The distribution in Afghanistan and E. Turkestan calls for some remarks. Birds from Kandahar in S. Afghanistan are *eversmanni* (Ticehurst, 1927, p. 73). From the N. W. border of Afghanistan, west of Herat, there are some skins (Nos. 14528, 14529, 14530) in the Indian Museum which are typical *eversmanni*, not intermediate between *eversmanni* and *oenas* as Stuart Baker (1913, p. 149) opined. These three skins are from Tirphul (34° 30′ N. lat. and 61° 30′ E. long); and Toman-Agha (34° 52′ N. lat. and 61° 2′ E. long.).

Columba palumbus Linnaeus.

The species ranges from W. Europe, south to N. Africa and *via* Asia Minor, Caucasus, Turkestan, Transcaspia, Palestine, Iraq and Iran to N. W. India (east up to Oudh) and the Himalayas (east up to Sikkim). Peters (1937, pp. 61, 62) admits six subspecies of which only *C. p. casiotis* occurs within the Indian limits.

Columba palumbus casiotis (Bonaparte).

(The Eastern Wood-Pigeon or Ring-Dove[1] or Cushat.)

1849. *Columba (Palumbus) torquatus* (part, "variety in N. W. Himalayas"), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 233, No. 1413.
1851 (Dec. 11). *Palumbus casiotis*, Bonaparte, *C. R. Acad. Sci. Paris* XXXIX, p. 1103. (Chinese Tartary.)
1854. *Palumbus casiotis*, Bonaparte, *Consp. Gen. Av.*, p. 42. (Himalayas.)
1928. *Columba palumbus casiotis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 227.
1937. *Columba palumbus casiotis*, Peters, *Check-list Birds World* III, p. 227.

Columba palumbus casiotis is represented in the collection of the Indian Museum by the following skins:—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
17289	♂	Gilgit (Kashmir).	Oct. 15, 1879	Dr. J. Scully.	247	178	35	..
17292	♀	Dangor (Gilgit, Kashmir).	Nov. 11, 1879	Dr. J. Scully.	247	179	..	..
17291	Juv. ♀	Gilgit (Kashmir).	Oct. 22, 1879	Dr. J. Scully.	[227	142	29	22]
3082	(?)	N. Simla, (Punjab).	(?)	Dr. F. Stoliczka.	258	165	33	20·5
3983	(?)	Kumaon (U. P.).	1867	"Riddell Mus."	253	190	32	20
9892	♂	Near Shiraz (S. Iran). [In oak forest, 6,000 ft.]	June 1870	Major St. John.	247	201	32	22
9893	Juv. ♀	Near Shiraz (S. Iran). [In oak forest, 6,000 ft.]	(?)	Major St. John.	[235	152	32	24]

[1] The name "Ring-Dove" is now used for *Streptopelia decaocto* (Frivaldszky)

Remarks.—In No. 9892 (Shiraz) the neck-patches are pale buff, conspicuously lighter than in *casiotis* from India but deeper than in *palumbus*.[1]

Distribution.—" Turkestan and Zaissan, south to eastern Persia, Baluchistan[2], the Salt Range and the Himalayas east to Sikkim. Migrates in winter south to Sind, the Punjab and Oudh " (Peters).

Columba elphinstonii (Sykes).

(The Nilgiri Wood-Pigeon.)

1833. *Ptilinopus Elphinstonii*, Sykes, *Proc. Comm. Zool. Soc. Lond.* (1832) II, p. 149. (The Ghats of Deccan.)
1849. *Columba (Palumbus) Elphinstonei*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 233, No. 1415.
1928. *Columba elphinstonii*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 228.
1937. *Columba elphinstonii*, Peters, *Check-list Birds World* III, p. 68.

Columba elphinstonii is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
26522	(?)	Nilgiris (S. India).	1848	Dr. T. C. Jerdon.	199	(154)	(37)	17
26523	(?)	Nilgiris (S. India.)	1848	Dr. T. C. Jerdon.	186	158	34	18
28914	(?)	" High range " (N. E. Travancore).	(?)	Trivandrum Mus.	208	158	29	18

Distribution.—" Hill tracts of southwestern India from Mahabaleshwar to Cape Comorin " (Peters).

Columba torringtoni (Bonaparte).

(The Ceylon Wood-Pigeon.)

1854 (Dec. 11). *Palumbus torringtoni*, " Layard ", Bonaparte, *C. R. Acad. Sci. Paris* XXXIX, p. 1103. (Ceylon.)
1854. *Palumbus torringtoni*. Bonaparte, *Consp. Gen. Av.* II, p. 42. (Ceylon.)
1928. *Columba torringtonii*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 229.
1937. *Columba torringtoni*, Peters, *Check-list Birds World* III, p. 68.

Columba torringtoni is represented in the collection of the Indian Museum by the following skin :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
26531	♂	Hakgalla (Ceylon). [*Hill Zone.*]	April 24, 1923	Colombo Mus., Ceylon.	180	(122)	26	18

Distribution.—" Confined to Ceylon " (Peters).

[1] Dr. C. B. Ticehurst said *in litt.* (Nov. 1940) that this difference is due to the fact the Shiraz birds were taken in June while the Indian birds were taken in winter.

[2] Stuart Baker (1928, p. 228) excludes Baluchistan. But Ticehurst (1927, p. 73; and 1930, p. 478) has shown that *casiotis* breeds in the juniper forests of northern Baluchistan; he also recorded a bird obtained as far south as Turbat in British Mekran on Nov. 27.

Genus **Alsocomus** Blyth.

Alsocomus puniceus Blyth.

(The Purple Wood-Pigeon.)

1842. *Columba (Alsocomus) Puniceus*, "Tickell", Blyth, *Journ. Asiat. Soc Bengal* XI, Pt. 1, p. 461. (Chyebassa, Burma.)
1849. *Columba (Alsocomus) puniceus*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 233, No. 1411.
1928. *Alsocomus puniceus*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 232.
1937. *Columba punicea*, Peters, *Check-list Birds World* III, p. 69.

Alsocomus puniceus is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor	Measurements (mm.).			
					W.	Tl.	Tr.	C.
3976	♂	Manbhum (E. Bihar).	(?)	Lt. Beavan.	210	(144)	29	18
7642	♂	Midnapore (Lower Bengal)	About 1874	W. Rutledge.	(223)	151	28	19
3977	♂	Cachar (Assam).	(?)	"Mus. Coll."	237	(162)	31	19
25272	(?)	Kobo, 400 ft. (N. E. Assam).	Dec. 5, 1911	Dr. S. W. Kemp (Abor Exped. 1911-12).	222	152	29	16
12917	♂	Gna Islet (Mergui Archipelago, S. Burma).	Feb. 18, 1882	Dr. J. Anderson (Mergui Exped.).	223	154	28	17
12918	♂	Gna Islet (Mergui Archipelago, S. Burma).	Feb. 15, 1882	Dr. J. Anderson (Mergui Exped.).	222	(156)	27	18

Remarks.—No. 25272 was wrongly identified as *Ducula insignis insignis* (Hodg.) by Stuart Baker (1913*a*, pp. 286, 287, specimen *b*).

Distribution.—" Eastern Bengal, Assam, Laos, south to the northern part of the Malay Peninsula, Siam and southern Annam " (Peters).

Some further remarks are necessary with regard to its distribution. Jerdon (1864, p. 462) recorded it from the " eastern portion of Central India, extending to near the sea coast in Midnapore and possibly southwards towards Cuttack ". Salvadori (1893, p. 397) listed a skin from " Central India ", and included the " Eastern part of Central India " in its range, probably on Jerdon's authority. Blanford (1898, p. 38) included in its range S. E. Bihar (Manbhum and Singhbhum) and " as far west as Sirguja " (=Surguja State in Chota Nagpur, C. P.). In the Indian Museum, No. 3976 is from Manbhum, and No. 7642 from Midnapur (Lower Bengal). Finally, Stuart Baker (1913, p. 177) has included the Sundarbans within its range.

Layard (1854, p. 58) recorded it from Ceylon where it probably occurs as a rare straggler (not as a seasonal immigrant as suggested by some authors). Legge (1880, p. 696) once observed a flock in Ceylon in 1869. The bird has never been recorded from S. India, and its occasional occurrence in Ceylon is rather mysterious.

Genus **Janthoenas**[1] Reichenbach.

Janthoenas palumboides (Hume).

(The Andaman Wood-Pigeon.)

1873. *Carpophaga palumboides*, Anonymous = Hume, *Str. Feath.* I, p. 302. (Port Mouat, S. Andaman Is.)
1874. *Ianthoenas nicobarica*, Walden, *Ann. Mag. Nat. Hist.* (4) XIV, p. 157 (Trinkut and Nangcowry Islands, Nicobars.)
1928. *Ianthoenas palumboides*, Stuart Baker, *Faun. Brit. Ind.*, *Birds* (2nd ed.), V, p. 233.
1937. *Columba palumboides*, Peters, *Check-list Birds World* III, p. 69.

Janthoenas palumboides is represented in the collection of the Indian Museum by the following skin :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
29675	(?)	Andamans. ..	(?)	Capt. R. A. S. Anderson.	235	..	31	18

Distribution.—" Andamans and Nicobars " (Peters).

Genus **Dendrotreron** Hodgson.

Dendrotreron hodgsonii (Vigors).

1832. *Columba Hodgsonii*, Vigors, *Proc. Comm. Zool. Soc. Lond.*, Pt. 2, p. 16. (Nepal.)
1849. *Columba (Alsocomus) Hodgsonii*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 233, No. 1410.
1928. *Dendrotreron hodgsonii*, Stuart Baker, *Faun. Brit. Ind.*, *Birds* (2nd ed.) V, p. 234.
1937. *Columba hodgsonii*, Peters, *Check-list Birds World* III, p. 64.

Dendrotreron hodgsonii is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
17327	♂	Gilgit (Kashmir).	June 24, 1879	Dr. J. Scully.	226	155	..	18
17328	♀	Kergah (Gilgit, Kashmir).	June 23, 1879	Dr. J. Scully.	224	151	..	16·5
26524	♀	Simla (Punjab).	1849	Asiat. Soc. Bengal.	233	(155)	28	16
3974	(♀)	Kumaon (U. P.).	(?)	" Riddell Mus."	233	171	27	18
3975	(♀)	Darjeeling (N. Bengal).	Winter of 1869-70.	H. J. Elwes.	220	135	25	17
4728	(♂)	Katmandu (Nepal).	(?)	(?)	226	165	(28)	19·5

Distribution.—" Resident between 8000 and 13000 feet in the Himalayas from Kashmir to Assam and south to Burma and the Shan States; western China in southern Kansu, western Szechuan and western Yunnan " (Peters).

[1] The spelling given by Neave (*Nomenc. Zool.* II, p. 806, 1939) is *Janthoenas*, not *Ianthoenas* which Stuart Baker (1928, p. 233) has used.

Genus **Streptopelia** Bonaparte.

Streptopelia turtur (Linnaeus).

The species ranges from W. Europe and N. Africa to the whole of S. W. Asia from the Khirgiz Steppes and Turkestan to Arabia, Iraq, Iran, Afghanistan and N. W. India. Peters (1937, p. 89) admits five subspecies. Of these only *arenicola* occurs with certainty within the Indian limits. According to Stuart Baker (1913, p. 187; 1928, p. 236), *S. t. turtur* is a rare staggler in extreme N. W. India but, as pointed out by Ticehurst (1930, p. 478), this contention is based on very slender and doubtful evidence.

Streptopelia turtur arenicola (Hartert).

(The Persian Turtle-Dove.)

1894. *Turtur turtur arenicola*, Hartert, *Novit. Zool.* I, p. 42. (Fao, S. Iran.) Type was in Tring Mus., England; now evidently in Amer. Mus. Nat. Hist.

1928. *Streptopelia turtur arenicola*, Stuart Baker, *Faun. Brit. Ind. Birds* (2nd ed.) V, p. 237.

1937. *Streptopelia turtur arenicola*, Peters, *Check-list Birds World* III, p. 89.

Streptopelia turtur arenicola is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Ts.	C.
21574	(Juv. ♂)	Little Pamir (E. Turkestan).	(?)	Dr. Alcock (Pamir Bound. Comm.).	[175	116	23·5	16,
22887	(?)	Kashgar (E. Turkestan).	Dec. 16, 1873	Dr. F. Stoliczka.	169	123	22	17
22886	(?)	Yarkand (E. Turkestan).	May 23, 1874	Dr. F. Stoliczka.	174	123	23	16
17316	♂	Yarkand (E. Turkestan).	May 28, 1875	Dr. J. Scully.	174	120	23	17
17317	♂	Yarkand. ..	May 30, 1875	Dr. J. Scully.	171	130	22	19
17318	♂	Yarkand. ..	May 31, 1875	Dr. J. Scully.	174	118	23	..
17319	♂	Yarkand. ..	June 2, 1875	Dr. J. Scully.	175	122	22	17
17320	♂	Yarkand. ..	June 10, 1875	Dr. J. Scully.	174	(123)	25	18
17321	♀	Yarkand. ..	May 28, 1875	Dr. J. Scully.	160	127	21	17
22888	(?)	Kargalik, near Yarkand (E. Turkestan).	May 30, 1874	Dr. F. Stoliczka.	175	132	24	15·5

(*b*)

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	W.	Tl.	Ts.	C.
26520	♀	Gilgit, 5,000 ft. (Kashmir).	May 26, 1879	(?)	171	121	23	17
10433	♀ (Juv.?)	Near Shiraz (Iran).	July 1869	Capt. St. John.	[160	106	20	16]
9804	♂	Near Shiraz, 6,000 ft. (Iran).	June 1870	Major St. John.	171	120	22	16
9932	♂	Near Bám, 2,500 ft. (Murmanshir, S. E. Iran).	April 19, 1872	Dr. W. T. Blanford.	162	123	22	16
10282	(?)	(?)	(?)	Dr. W. T. Blanford. (Persian Coll.)	171	(122)	21	16

Remarks.—Hartert (1920, p. 1486) and Stuart Baker (1928, p. 237) state that birds from southern Iran. Turkestan (east up to Kashgar and Yarkand), Afghanistan, Baluchistan, Iraq, etc. are paler and smaller than the typical birds, *S. t. turtur*, from Europe. The wing-length given is 163-177 mm. (Hartert) and 161-181 mm. (Stuart Baker), while for the typical race *turtur* the figures are 163-182 mm. but mostly 173-178 mm. (Hartert) and 165-184 mm. (Stuart Baker); *arenicola* is generally regarded as smaller than *turtur*.

Hartert (1894, p. 42), who first separated the southern Iranian birds into a separate race *arenicola*, had stated that "the birds from Yarkand might also be distinguished subspecifically", but later (1920, p. 1486) he regarded the Yarkand birds as *arenicola*.

The Turkestan and Iranian birds in the Indian Museum fall into separate groups [Tables (*a*) and (*b*) above], the Iranian birds being markedly paler and smaller, as shown by the following measurements (mm.):—

		Wing	Tail	Tarsus	Culmen
E. Turkestan ..	5 ♂♂:	171-175	118-130	22-25	17-19
	1 ♀:	169	127	21	17
	3 o?:	169-175	123-132	22-24	15·5-17
Iran	2 ♂♂:	162-171	123-129	22	16
	1 o?:	171	(122)	21	16

No. 26529 from Gilgit resembles the Iranian birds in plumage. Having no typical European birds for comparison, I cannot go further into the question.

Distribution.—"Breeds in northern Africa from Morocco to Tripoli; in southwestern Asia from the Kirghiz Steppes to Turkestan south to Iraq, Persia, Afghanistan and Yarkand. Recorded as a migrant in Egypt, Yemen, and the Danakil country, and as wintering in northwestern India" (Peters).

Streptopelia orientalis (Latham).

The species ranges from Siberia in the north to Iran and India in the south, and China, Japan, Formosa and Hainan Island in the east. Peters (1937, pp. 89, 90) admits five subspecies. Of these, three occur within the Indian limits. Koelz (1939, p. 81) recently created a sixth race, *sylvicola*, based on six specimens from Castle Rock, Bombay Presidency. From Koelz's description, *sylvicola* seems hardly separable from *agricola* Tickell.

The uncertainty of the nomenclature of two of the three subspecies occurring within the Indian limits has led to considerable confusion in the past. Among those who have discussed the question from various angles are the following:—Hartert (1916, p. 80; 1920, pp. 1488-1490), Hartert & Steinbacher (1936, p. 458), Rothschild (1926, p. 223), Ticehurst (1930, p. 478), Ludlow & Kinnear (1934, pp. 97, 98) and, finally, Whistler & Kinnear (1936, pp. 677-679). Ludlow & Kinnear have finally settled the question of nomenclature, while Whistler & Kinnear have given an excellent summary of the distribution of the subspecies in India,

The three main views on nomenclature are summarised below :—

Common name	Under tail coverts	Subspecific name		
		View No 1 (Correct one adopted in present account)	*View No 2* (Adopted by Stuart Baker in *Faun Brit Ind*)	*View No 3*
1. Rufous Turtle-Dove.	Pale dove-grey	*orientalis* Latham.	*orientalis* Latham.	*orientalis* Latham.
2 Northern Indian Rufous Turtle-Dove	White	*meena* Sykes.	*ferrago* Eversmann	*ferrago* Eversmann
3 Indian Rufous Turtle Dove	Dark grey	*agricola* Tickell.	*meena* Sykes	*agricola* Tickell

Streptopelia orientalis orientalis (Latham).

(The Rufous Turtle-Dove.)

1790 *Columba orientalis*, Latham, *Index Orn* II, p 606 (China, ex Sonnerat)
1849 *Turtur orientalis* (part), Blyth, *Catal Birds Mus Asiat Soc Bengal*, p 236, No 1436
1928 *Streptopelia orientalis orientalis*, Stuart Baker, *Faun Brit Ind*, *Bird* (2nd ed) V, p 238.
1937 *Streptopelia orientalis orientalis* Peters, *Check list Birds World* III p 89.

Streptopelia orientalis orientalis is represented in the collection of the Indian Museum by the following skins :-

Reg No	Sex	Locality	Date	Collector or Donor	Measurements (mm).			
					W	Tl	Tr	C
25787	♂	Mipi, 8 500 ft (Mishmi Hills N E Assam)	March 9 1913	Capt R S Kennedy	197	141	29	16
20913	♂	Foochow (S E China)	Oct. 1870	C B Rickett	194	138	29	19

Remarks. -The bird is stated by some to be common in the hills of Yunnan up to about 7,000 feet (*vide* Rothschild 1926, p. 233). Rothschild refers to some of Anderson's specimens. There are in the Indian Museum two of Anderson's skins labelled *Turtur gelastes* Tem., one from " Ponsee ", W. Yunnan (April 11, 1868) and another from " Katha Up. Burma " (January 19, 1868)—both are *agricola* (Tickell) as listed below (p. 332). However, Rothschild refers one of Anderson's skins from Ponsee (♂, March 1868) to *S. o. orientalis*, although Anderson had referred it to *meena*. The statement of Stanford & Ticehurst (1939, p. 215) that " Anderson's records nominally from Yunnan, are really from Burma " is not quite correct since some of Anderson's skins of the Rufous Turtle-Doves *were* from Yunnan (see p. 332).

Distribution. " Breeds from central Siberia, Transbaikalia, Amurland and Island of Sakhalin south to the Himalayas, northern

Assam, Yunnan Kwangtung and Island of Kiusiu. Winters over the greater part of eastern India, Indo-Chinese countries, southern China, the Japanese Islands, Formosa and Hainan " (Peters).

Streptopelia orientalis meena (Sykes).

(The Northern Indian Rufous Turtle-Dove.)

1832. *Columba Meena*, ♂, Sykes, *Proc. Comm. Zool. Soc. Lond.* II, p. 149. (Deccan.)
1842. *Columba ferrago*, Eversmann, *Addenda Pallas Zoogr. Rosso-Asiat.*, fasc. 3, p. 17. (Songaria and mountains of Tarbagati, Mongolia.)
1928. *Streptopelia orientalis ferrago*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 239.
1937. *Streptopelia orientalis meena*, Peters, *Check-list Bird World* III, p. 90.

Streptopelia orientalis meena is represented in the collection of the Indian Museum by the following skins :

Reg. No.	Sex.	Locality.	Date	Collector or Donor.	Measurements (mm.). W.	Tl.	Tr.	C.
22800	(?)	" S. W of Eglsva " (= Igluzvar) (E Turkestan).	May 18, 1874	Dr. F. Stoliczka	193	139	27	16
14301	(Juv.?)	Chilik (Afghan Turkestan, not Iran).	July 2, 1886	Capt. Yate (Afghan Bound. Comm.).	[166	118	23	16]
17207	♂	Sharot (Gilgit, Kashmir)	April 28, 1879	Dr. J. Scully.	193	149	28	..
17298	[illegible]	Gilgit (Kashmir)	May 1, 1879	Dr. J. Scully.	197	141	27	16
22884	(?)	Chuliscambo (Ladak, Kashmir).	Aug. 18, 1873	Dr. F. Stoliczka	185	126	23	15
17299	♀	" Singal, Punjab " (? Gilgit, Kashmir).	May 27, 1879	Dr. J. Scully.	189	(140)	24	18
6401	♂	Kangan, near Srinagar (Kashmir).	June 15, 1870	Dr. G. Henderson (Forsyth' First Yarkand Exped.)	184	(139)	25	17
6105	♂	Kangan, near Srinagar (Kashmir).	June 15 1870	(Forsyth' First Yarkand Exped.).	188	138	27	16
4064	(?)	Kyelang (or Keylang) Lahul (?Kangra District), (Punjab)	(?)	Dr. F. Stoliczka.	189	127	26	16
17315	♂	Kansrao (Dehra Dun District, United Provinces).	April 2, 1870	(Mr. G. Kl or Dr. J. Scully ?).	187	148	27	17
11804	♀	" Bhoura " (= Bavda), 2,500 ft. (Kolhapur State, Bombay Pres.).	April 7, 1878	Surg. J. Armstrong.	183	135	25	15
11802	♂	" Bhoura " (= Bavda), 2,500 ft.	April 8, 1878	Surg. J. Armstrong.	189	140	27	16
11359	♂	" Bhoura " (= Bavda), 2,500 ft.	April 10, 1878	Surg. J. Armstrong.	190	137	28	17
11264	♀	" Bhoura " (= Bavda), 2,500 ft.	April 10, 1878	Surg. J. Armstrong.	188	134	25	18
11803	♂	" Bhoura " (= Bavda), 2,500 ft.	April 11, 1878	Surg. J. Armstrong.	191	142	27	16·5
11263	♀	" Bhoura " (= Bavda), 2,000 ft.	April 11, 1878	Surg. J. Armstrong.	180	131	26	15
11360	♂	" Bhoura " (= Bavda), 1,500 ft.	April 10, 1878	Surg. J. Armstrong.	184	133	27	..
11138	♂	" Bhoura " (= Bavda), 2,500 ft.	April 10, 1878	Surg. J. Armstrong.	188	131	26	17

Remarks. Hartert (1920, p. 1490) gave the wing-length as 187-202 mm., mostly about 195 mm. Stuart Baker's (1928, p. 240) figures are: "169-200 mm., but nearly always over 175 mm." In the 17 adult skins in the Indian Museum, the wing measures 180-197 mm., the majority being grouped closely around 188-189 mm.

Distribution. "Breeds in the southern part of western Siberia east to the western Altai; Turkestan, Persia, Afghanistan, Kashmir and the Himalayas east to western Nepal Winters over the whole of western and southern India" (Peters).

The following further remarks are necessary.

The bird does not occur over the whole of W. India it avoids the desert areas of Sind and Rajputana.

Ticehurst (1927, p. 73) has recorded two birds on passage (October 1 and June 3) from Quetta in Baluchistan.

Whistler & Kinnear (1936, pp. 677, 678) have quoted several records from the western and eastern coast of Peninsular India down to about lat. 12°N.; in the Indian Museum there are several Armstrong skins (April 7-19) from the Kolhapur State in the Bombay Presidency. Below 12°N. lat., there are no records from the mainland of India.

It occurs as a winter straggler in Ceylon (Wait, 1931, p. 296)[1].

There is a skin, No. 17315 (April 2), in the Indian Museum from the Dehra Dun District, U. P. There are several records from Bihar where it is said to be common in winter.

Stuart Baker's statement (1913, p. 200) that it is certainly an occasional straggler in Dhubri (Assam) needs confirmation.

Another statement of Stuart Baker (1928, p. 240) that "Rothschild accepts Anderson's record of this race from Yunnan" is incorrect. Rothschild (1926, pp. 223, 231) does not accept it as a Yunnan bird at all. Neither Mayr (1938, p. 317) nor Stanford & Ticehurst (1939, pp. 215, 216) have recorded it from N. Burma where the race *orientalis*, and not *meena*, is found.

The Indian distribution may thus be summed up as follows: Breeds in Kashmir and the Himalayas east up to western Nepal where it intergrades with the darker race, *agricola* Tickell: breeding birds (intermediates?) may occasionally be found in the plains of Bihar. Winters in the whole of India (excluding the desert areas of Sind and Rajputana, etc.) east up to Bihar. Migrating birds met with in Baluchistan. Stragglers occur in Ceylon in winter.

Streptopelia orientalis agricola (Tickell).

(The Indian Rufous Turtle-Dove.)

1833. *Columba Agricola*, Tickell, *Journ. Asiat. Soc. Bengal* II, p. 581. (Jungles of Borabhum and Dholbhum, Bihar.)
1928. *Streptopelia orientalis meena*, Stuart Baker, *Faun. Brit. Ind. Birds* (2nd ed.) V, p. 240.
1937. *Streptopelia orientalis agricola*, Peters, *Check-list Birds World* III, p. 90.

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[1] Stuart Baker (1930, p. 689) has wrongly referred this record to *S. o. agricola*, see foot-note on p. 332.

Streptopelia orientalis agricola is represented in the collection of the Indian Museum by the following skins: --

Reg. No.	Sex	Locality	Date.	Collector or Donor	Measurements (mm.). W	T.	Ts.	C.
14018	♂	Kendrapara (Orissa)	Aug 1888	"Mus Coll."	176	134	27	15
14019	♀	Kendrapara (Orissa)	Aug 1888	"Mus Coll."	173	121	26	17(?)
4063	(?)	Manbhum (Bihar)	(?)	Lt. Beavan.	171	118	27	18
25751	♀	Kuru (Ranchi District, Bihar).	Oct. 22, 1927	Dr S. C. Law	185	..	27	18
25530	(?)	Jessore (E. Bengal).	(?)	T. C. Tweedie.	168	133	26	16
24582	♂	South Sylhet (Assam)	(?)	C. B. Antram.	163	110	25	17
8272	♀	Thayetmyo (Burma)	May 24, 1877	Dr F. Stoliczka	182	130	27	18
23221	♀	Kalaw 4,300 ft. (S. Shan States, Burma).	Nov. 23, 1899	Col. C. T Bingham	184	140	25	18
23223	♀	Banque (S. Shan States, Burma)	Dec. 20, 1899	Col. C. T. Bingham.	175	131	26	17
9085	(?)	Katha (Upper Burma).	Jan. 19, 1868	Dr. J. Anderson.	181	..	33	(17)
9084	(?)	Ponsee, 3,300 ft (Kakhyen Hills, Yunnan).	April 11 1868	Dr. J. Anderson.	188	142	27	16

Remarks. Rothschild (1926, pp. 223, 231) accepted Anderson's record of this race from Yunnan. He wrote that an Anderson skin of "*Turtur gelastes*" from Tsitkaw (February 1875) in the British Museum is "*meena*" (*agricola* Tickell). In the Indian Museum there are two Anderson skins, No. 9084 (Ponsee, Kakhyen Hills, W. Yunnan, April 11) and No. 9085 (Katha, Upper Burma, January 19) labelled *Turtur gelastes*: they are *agricola* Tickell. These records, and that of Andrews & Heller (*vide* Rothschild, *loc. cit.*) from Ho-mu-shu Pass, W. Yunnan, April 17, would suggest the inclusion of S. W. Yunnan within the range of *agricola*.

Distribution.- "Resident in northeastern India in Bihar, Orissa and Bengal: southern Assam, and Burma south to Tenasserim" (Peters).

On the basis of the remarks given above, S. W. Yunnan may be included within its range.

In winter it may straggle as far south-west as Mahabaleshwar, Bombay Presidency (Stuart Baker, 1928, p. 241).

The statements of Whistler (1928, p. 302) and Stuart Baker (*loc. cit.*) that the bird breeds both in the Deccan and Central Provinces is, so far as I know, not supported by actual records.

Stuart Baker's (1930, p. 689) statement that Wait has recorded it from Ceylon is incorrect[1].

Streptopelia decaocto (Frivaldszky).

The species ranges from Hungary *via* S. E. Europe, Iran, India and Turkestan to China and Japan in the east. Peters (1937, p. 92) admits

[1] The only Turtle-Dove which Wait (1931, p. 296) records as occurring in Ceylon is *ferrago* Evers. (= *meena* Syk.) with white under tail-coverts.

three subspecies of which two occur within the Indian limits (*vide* also Roonwal, 1940. pp. 437-452). Ticehurst (1929, pp. 7-10) has suggested that *S. decaocto* (Frivaldszky) should perhaps retain the older name *S. risoria* (Linnaeus).

Streptopelia decaocto decaocto (Frivaldszky).

(The Indian Ring-Dove.)

[1758. ?*Columba risoria*, Linnaeus, *Syst. Nat.* (10th ed.) I, p. 165. (India.) Considered by some as applying to domesticated forms only.]
1838. *Columba risoria* Linn., variety *decaocto*, Frivaldszky. *K. magyar tudos Társasáq Evkönyei* III, Pt. 3, p. 183. (Turkey.)
1849. *Turtur risorius* (part ?), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 235. (Part habitat, N. Africa, *errore* ?)
1928. *Streptopelia decaocto decaocto* (part). Stuart Baker. *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 248.
1937. *Streptopelia decaocto decaocto*, Peters, *Check-list Birds World* III, p. 92.
1940. *Streptopelia decaocto decaocto*, Roonwal, *Rec. Ind. Mus.* XLII, p. 440.

Streptopelia decaocto decaocto is represented in the collection of the Indian Museum by the following skins:—

Reg. No.	Sex.	Locality.	Date	Collector or Donor	Measurements (mm.).			
					W.	Tl	Tr.	C.
24588	♂	Khwaja Ahmad (Seistan, E. Iran).	May 7 1905	J. W. N. Cumming.	(161)	110	23	16
9980	♀ (Juv.?)	Pishin (Baluchistan).	Feb. 10 1872	Mr. W. T. Blanford	[161	128	23	15]
17322	♂	Mt. Abu (Rajputana).	May 22. 1868	Mr. S. King	167	(135)	23	..
25733	♀	Rajadara (Ranchi District, Bihar)	Oct 18. 1927	Dr. S. C. Law	171	118	23	16
25739	♀	Chandwa (Ranchi-Palamau border, Bihar).	Oct. 22, 1927	Dr. S. C. Law.	168	139	23	16
4058	(?)	Manbhum (E. Bihar).	(?)	"Mus. Coll."	167	133	21	15
4060	(?)	Manbhum (E. Bihar)	(?)	"Mus. Coll."	176	118	25	17
4061	(?)	Singhbhum (E. Bihar).	(?)	Mr. V. Ball,	175	110	27	15
4333	(?)	Nepal.	(?)	(?)	172	110	..	16
4059	♂	Nagpur (Central Provinces).	(?)	Mr. W. T. Blanford.	171	130	21	17
4062	(?)	S. E. Berar. ..	(?)	Mr. W. T. Blanford.	161	131	22	15
11902	♂	Phonda (Ratnagiri District. Bombay Presidency).	May 23, 1878	Surg. J. Armstrong.	161	130	25	(13)
18142	♀	Near Bangalore (Mysore State).	(?)	"Mus. Coll. Jaffa."	160	132	22	15·5
20533[1]	(Juv.?)	Calcutta.	(1842-45)	Asiat. Soc., Bengal.	[155	..	23	18]

[1] This is No. 1430 *H* of Blyth's *Catal. Birds Mus. Asiat. Soc. Bengal*, pp. 235, 236 (1849), where it is described as "Young. (White race)", under *Turtur risorius*. The plumage of the specimen is entirely white. I have included this identification on Blyth's authority.

Remarks.—Stuart Baker (1928, p. 248) included under *S. d. decaocto* the E. Turkestan birds also; the latter are really *S. d. stoliczkae* Hume (see p. 351).

The Indian specimens of *S d decaocto* in the Indian Museum give a wing-length of 160 176 mm average 168 mm

Distribution ' Resident from Hungary over southeastern Europe, Asia Minor Turkestan northern China and Japan south to Palestine, Iraq, Persia India, Ceylon and western China A pale variety found under domestication (Peters)

Streptopelia decaocto xanthocyclus (Newman)

(The Burmese Ring-Dove)

1906 *Turtur decaocto xanthocycla* Newman *Avic Mag* (N S) IV p 324 and fig 1 [col] plate (Minbu and Magwe District Upper Burma)

1928 *Streptopelia d xanthocycla* Stuart Baker *Faun Brit Ind Birds* (2nd ed) V p 249

1937 *Streptopelia decaocto xanthocyclus* Peters *Check-list Birds World* III p 92

1940 *Streptopelia decaocto xanthocyclus* Roonwal *Rec Ind Mus* XLII p 449

Streptopelia decaocto xanthocyclus is represented in the collection of the Indian Museum by the following skin

Reg No	Sex	Locality	Date	Collector and Donor	Measurements (mm) W	T	B	C
[illegible]	(?)	Upper defile Irrawaddy about 40 miles below Bhamo (N Burma)	Sept 1868	Dr J Anderson	[illegible]	[illegible]	[illegible]	(17)

Remarks The single Anderson skin in the Indian Museum agrees with Anderson's description (1879 p 666) in that the ' colour generally is darker and more vivid than in Indian specimens of the species (*S d. decaocto*), and the collar is larger and more crescentic ", it is also "decidedly larger (*vide* Roonwal 1940)

Distribution —" Burma Shan States Yunnan and eastern China (lower Yangtse Valley and Fohkien (Peters)

Streptopelia chinensis (Scopoli)

The species extends from W India (excluding Sind and the Punjab), to China, Formosa and the Philippines in the east and south to Ceylon, the Malay Peninsula and the East Indies Peters (1937, pp 97, 98) admits eight subspecies of which four occur within the Indian limits

Streptopelia chinensis suratensis (Gmelin)

(The Indian Spotted Dove)

1789 *Columba suratensis* Gmelin, *Syst Nat* I Pt 2 p 778 (Surat, Bombay Presidency ex Sonnerat, *Voy Indes* II p 179)

1849 *Turtur suratensis* (part) Blyth *Catal Birds Mus Asiat Soc Bengal*, p 236, No 1435

1928 *Streptopelia chinensis suratensis* Stuart Baker, *Faun Brit Ind , Birds* (2nd ed) V, p 242

1937 *Streptopelia chinensis suratensis*, Peters, *Check-list Birds World* III, p 97

Streptopelia chinensis suratensis is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex	Locality	Date	Collector or Donor	Measurements (mm.) W	B	Ta	C
17[illegible]08	(Juv.)	[illegible]	Nov. 11, 187[illegible]	Dr. J. Scully	[1[illegible]	1[illegible]	[illegible]2	1[illegible]
17[illegible]0[illegible]	(Juv.)	[illegible] (Kathmandu)	Nov. [illegible] 187[illegible]	Dr. J. Scully	[11[illegible]	117	[illegible]2	[illegible]
17[illegible]0[illegible]	♂ (Juv.)	[illegible] (K[illegible])	D[illegible] 18, 187[illegible]	Dr. J. Scully	[1[illegible]	(1[illegible])	[illegible]	10[illegible]
17[illegible]10		[illegible] (K[illegible])	F[illegible] 1880	Dr. J. Scully	1[illegible]0	1[illegible]	([illegible]0)	1[illegible]5
17[illegible]00	(Juv.)	[illegible]	Oct. 17, 187[illegible]	Dr. J. Scully	[1[illegible]0	(1[illegible]0)		1[illegible]
28[illegible]	( )	[illegible] hills [illegible] Murree (Rawalpindi District, Punjab)	July [illegible] 187[illegible]	Dr. F. Stoliczka	1[illegible]0	(1[illegible])	[illegible]2	1[illegible]
22891	(?)	[illegible] (Punjab ?)	July 20, 187[illegible]	Dr. F. Stoliczka	1[illegible]7	1[illegible]2	21	
17[illegible]04	♂ (Juv.)	[illegible] [Kathmandu] Nepal Valley	Feb. [illegible] 187[illegible]	Dr. J. Scully	[128	11[illegible]	2[illegible]	1[illegible]
17[illegible]01	♂	Kathmandu (Nepal)	April 19, 187[illegible]	Dr. J. Scully	1[illegible]	1[illegible]	24.5	1[illegible]
17[illegible]0[illegible]	♂	Kathmandu (Nepal)	May [illegible] 187[illegible]	Dr. J. Scully	1[illegible]	1[illegible]	20	1[illegible]
17[illegible]0[illegible]		[illegible] [Kathmandu] Nepal Valley	Jun[illegible] 187[illegible]	Dr. J. Scully	1[illegible]	1[illegible]	[illegible]	15
[illegible]18[illegible]	(?)	Kathmandu (Nepal)	(?)	(?)	110	1[illegible]	21[illegible]	16
17[illegible]30	♂	[illegible] (Nepal)	Sept. [illegible] 187[illegible]	Dr. J. Scully	1[illegible]	(1[illegible])	[illegible]	16
40[illegible]2	(?)	Darjeeling (N. Bengal)	(?)	Dr. J. Anderson	1[illegible]	1[illegible]	18	
4031	♂	Darjeeling (N. Bengal)	(?)	Dr. J. Anderson	1[illegible]	1[illegible]		(11)
40[illegible]4	(?)	Darjeeling [illegible] (N. Bengal)	(?)	Dr. J. Anderson	1[illegible]0	1[illegible]		1[illegible]
20[illegible]41[illegible]	(?)	[illegible] Dist. N. Bengal	N[illegible] 19[illegible]	Zool. Survey of India	1[illegible]	112	[illegible]	1[illegible]
4011	♂	M[illegible] (Midnapore Dist., W. Bengal)	Jan. 1870	Mr. J. Wood-Mason	1[illegible]	(118)	[illegible]	1[illegible]
4015	(?)	Midnapore (W. Bengal)	Jan. [illegible] 1870	Mr. J. Wood-Mason	112	1[illegible]2	23	16.5
256[illegible]	(?)	[illegible] (Nadia Dist., Bengal)	Aug. [illegible] 19[illegible]7	Mr. A. Rahman	[illegible]8	1[illegible]	2[illegible]	11[illegible]
40[illegible]7	(?)	Calcutta	Au[illegible] 1, 1867	Mus. Coll.	132	(110)	21[illegible]	1[illegible]
40[illegible]	♂	Calcutta	Oct. 186[illegible]	Dr. J. Anderson	1[illegible]2	133	23	1[illegible]
26308 (Mounted in gallery)	♂	Indian Museum Garden, Calcutta	Mar. 2, 19[illegible]	Mr. R. N. Sherard	1[illegible]	13[illegible]		17
2[illegible]32	♂	Pulta Water Works, 17 miles N. of Calcutta	Oct. 6, 19[illegible]	Dr. M. L. Roonwal	132	1[illegible]	25	15
24567	♀	South Sylhet (Assam)	(?)	C. B. Antram	111	117	24	15
24580	♂	South Sylhet (Assam)	(?)	C. B. Antram	1[illegible]	1[illegible]	22	(15)
24592	(?)	South Sylhet (Assam)	(?)	C. B. Antram	137	143	23	1[illegible]
4041	♀	Singhbhum (Bihar)	Feb. 6, 18[illegible]	Mr. V. Ball	137	115	25	1[illegible]5

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
25755	♂	Angara (Ranchi District, Bihar)	Oct. 12, 1927	Dr. S. C. Law.	134	142	23	15
1039	♂	"Chota Nagpur." .	Dec. 1868	Mr. V. Ball.	140	..	23	15
1046		West of Chanda (Central Provinces)	Jan. 1, 1870	Mr. W. T. Blanford.	135	137	22	14
17311	[illegible]	Mt. Abu (Rajputana).	Jan. 1, 1868	Mr. S. King.	136	127	24	15
17312	♀	Mt. Abu (Rajputana).	Apr. 27, 1868	Mr. S. King.	138	137	23	15·5
18318	(?)	Ahmadabad (Gujrat).	(?)	H. E. M. James.	140	(140)	22	16
11362	♂	Waghotan (Vaghotan) (Ratnagiri District Bombay Pres.).	Mar. 1, 1878	Surg. J. Armstrong.	132	157	23	..
11086	[illegible]	Waghotan (Vaghotan) (Ratnagiri District, Bombay Pres.).	Feb. 28, 1878	Surg. J. Armstrong.	(135)	148	22	..
11905	♂	"Bhoura" (Bavda), 2,500 ft. (Kolhapur State, Bombay Presidency).	Mar. 27, 1878	Surg. J. Armstrong.	133	139	21	..
11453	♂	"Bhoura" (Bavda), 2,000 ft.	Apr. 3, 1878	Surg. J. Armstrong	138	146	24	16
11903	♂	"Bhoura" (Bavda), 2,000 ft.	Apr. 3, 1878	Surg. J. Armstrong.	136	145	21	..
11365	♂	"Bhoura" (Bavda). 2,000 ft.	Apr. 3, 1878	Surg. J. Armstrong.	133	134	23	15
22893	[illegible]	"Bhoura" (Bavda). 2,000 ft.	Apr. 3, 1878	Surg. J. Armstrong.	137	143	24	16
11363	♂	"Bhoura" (Bavda). 2,000 ft.	Apr. 4, 1878	Surg. J. Armstrong.	141	141	22·5	15
11904	[illegible]	"Bhoura" (Bavda) 2,000 ft.	Apr. 7, 1878	Surg. J. Armstrong.	132	140	22	..
11364	[illegible]	"Bhoura ♣(Bavda). 2,000 ft.	Apr. 7, 1878	Surg. J. Armstrong	132	137	24	15
11085	♂ (Juv.?)	"Bhoura" (Bavda). 2,000 ft.	Apr. 10, 1878	Surg. J Armstrong.	[123	116	22	..]
18543	♂	Near Bangalore (Mysore State).	(?)	"Mus. Coll. Jaffa."	135	139	24	15
18544	♀	Near Bangalore (Mysore State).	(?)	"Mus. Coll. Jaffa."	137	(136)	22	15·5
23924	♂	Deviculum (Travancore).	Feb. 1892	Trivandrum Mus.	130	136	22	14
23925	(?)	Deviculum (Travancore).	Feb. 1892	Trivandrum Mus.	128	130	21·5	14
1043	(?)	"Travancore." ..	(?)	(Purchased.)	127	139	23	13
1042	(?)	"Travancore." ..	(?)	(Purchased.)	127	127	23	16
1040	♂	Chasri (?). ..	1865	Dr. F. Stoliczka.	138	(141)	24	16
22804	(Juv.)	(?)	(?)	(?)	[134	..	(24)	16]
24512	(?)	(?)	(?)	(?)	134	(128)	22	15

Distribution.—"All of India (but absent from a large area of Sind and Punjab) and in the Himalayas up to 7,000 feet; birds from Cachar and Manipur form the transition to *S. c. tigrina* and those from Travancore tend towards *S. c. ceylonensis*. Introduced into Mauritius" (Peters).

Streptopelia chinensis tigrina (Temminck).

(The Burmese Spotted Dove.)

1810. *Columba Tigrina*, Temminck, in Knip, *Les Pigeons* I, p. 94, pl. 43. (Timor and Batavia in E. Indies. According to Hartert, 1920, p. 1491, the type in the Paris Museum is from Java.)

1928. *Streptopelia chinensis tigrina*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 244.

1937. *Streptopelia chinensis tigrina*, Peters, *Check-list Birds World* III, p. 98.

Streptopelia chinensis tigrina is represented in the collection of the Indian Museum by the following skins: -

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
8271	♀	Thayetmyo (Burma).	Dec. 21, 1871	Dr. F. Stoliczka.	132	139	23	13
1017	(?)	Burma.	(?)	Dr. Williams.	145	157	25	16
9067	(?)	Upper Burma. ..	Jan. 1868	Dr. J. Anderson.	140	162	24	15
9068	(?)	Upper Burma. ..	Jan. 11, 1868	Dr. J. Anderson.	147	155	27	16
9069	♂	Nayleyman (Upper Burma).	Jan. 5, 1875	Dr. J. Anderson.	140	147	25	14·5
9077	♂	Ava (Upper Burma).	Oct. 1, 1868	Dr. J. Anderson.	147	169	25	16·5
9078	(?)	Ava (Upper Burma).	Oct. 1, 1868	Dr. J. Anderson.	147	153	23	14
9079	(?)	Katha (Upper Burma).	Jan. 19, 1868	Dr. J. Anderson	130	140	25	14
9070	(?)	"Bhaman" (Bhamo?) (Upper Burma)	Sept. 8, 1868	Dr. J. Anderson.	147	149	24	16
9071	(?)	"Bhaman" (Bhamo?) (Upper Burma)	Sept. 11, 1868	Dr. J. Anderson	141	162	27	17
9072	(?)	"Bhaman" (Bhamo?) (Upper Burma).	Sept. 3, 1868	Dr. J. Anderson.	141	155	25	16
9074	(?)	"Bhaman" (Bhamo?) (Upper Burma).	Feb. 1868	Dr. J. Anderson.	141	160	24	16
9075	(?)	"Bhaman" (Bhamo?) (Upper Burma).	Feb. 28, 1868	Dr. J. Anderson.	149	149	26	15
9076	(?)	"Bhaman" (Bhamo?) (Upper Burma).	Oct. 7, 1868	Dr. J. Anderson.	141	141	24	14
9066	(?)	Tapeng (Upper Burma).	Mar. 1, 1868	Dr. J. Anderson.	147	155	25	17
9082	(?)	Ponsee (Kakhyen Hills, W. Yunnan, China).	Mar. 16, 1868	Dr. J. Anderson.	137	138	24	15
9083	(?)	Ponsee, 3,300 ft. (Kakhyen Hills, W. Yunnan, China).	Mar. 11, 1868	Dr. J. Anderson.	147	140	22	15
9081	(?)	Muangla-Sanda Valley, 3,000 ft. (W. Yunnan, China).	May 18, 1868	Dr. J. Anderson.	143	130	23	14·5
9080	(♂)	Momien, 5,500 ft. (W. Yunnan, China).	June 5, 1868	Dr. J. Anderson.	157	155	28	15

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
8115	♂	Meetan (= Mitan) (Amherst District, S. Burma).	Jan. 1, 1877	"Tenasserim Exped."	145	140	22	16·5
8116	♂	Houngdaraw River (Amherst District, S. Burma).	Jan. 29, 1877	"Tenasserim Exped."	141	.	27	15
8117	♀ (Juv.)	Houngdaraw River (Amherst District, S. Burma).	Feb. 27, 1877	"Tenasserim Exped."	[136]	128	25	17]
12913	(?)	"Taing" (Mergui, S. Burma).	Jan. 31, 1882	Dr. J. Anderson	138	152	25·5	15·5
12915	♂	"Yeemuku" (Mergui, S. Burma).	Jan. 24, 1882	Dr. J. Anderson	148	(160)	26	15
4048	(?)	Wellesly Prov. (Malay Penin.).	(?)	(Purchased.)	139	146	27	16
13460	(Juv.)	Malacca (Malay Penin.).	(?)	Bengal Economic Mus.	[(137)	135	22	14]
13459	(Juv.)	Malacca (Malay Penin.).	(?)	Bengal Economic Mus.	[133	.	25	..]
					(Head missing.)			

Remarks.—I have included a few birds from W. Yunnan under *tigrina*, as I am unable to separate these from the *tigrina* obtained from all over Burma. Some authors refer W. Yunnan birds to the race *forresti* which, however, is considered by Peters (1937, p. 98) as doubtfully distinct from *tigrina*.

Distribution (of *tigrina* 'senu stricto') "Eastern Bengal, Burma, Malay Peninsula, Indo-Chinese countries, Palawan, Borneo, Sunda Islands from Sumatra to Babar. Introduced into Celebes, small islands in the Flores Sea, and the Moluccas" (Peters).

Streptopelia chinensis ceylonensis (Reichenbach).

(The Ceylonese Spotted or Ash Dove.)

1851. *Turtur ceylonensis*, Reichenbach, *Vollst. Natursyst., Tauben*, pl. 253*b*, figs. 3373, 3374. (Ceylon.)
1928. *Streptopelia chinensis ceylonensis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 245.
1937. *Streptopelia chinensis ceylonensis*, Peters, *Check-list Birds World* III, p. 97.

Streptopelia chinensis ceylonensis is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
20549	♂	Passara (Ceylon). [*Hill Zone.*]	Dec. 3, 1920	Colombo Mus., Ceylon.	12[illegible]	12[illegible]	24	15
20550	♂	Hakgella (Central Prov., Ceylon). [*Hill Zone.*]	Apr. 24, 1924	Colombo Mus., Ceylon.	127	120	19	15·5

Distribution.—"Ceylon" (Peters).

Streptopelia senegalensis (Linnaeus).

The species ranges over the whole of Africa; farther east it occurs in Arabia, Palestine, Syria, Asia Minor, and thence to Iran, Afghanistan, Russian Turkestan and practically the whole of India (excluding the extreme eastern portion of the mainland, and also excluding Burma and Ceylon). Peters (1937, pp. 98-100) admits nine subspecies of which only one, *cambayensis* two, *cambayensis* and *ermanni*, according to some —occurs within the Indian limits.

The trivial name calls for some comment. The African races go under the name "Laughing Doves". Since the type-locality of the species is in Africa, it is desirable that all races should follow a trivial nomenclature identical to that of the African races. In Indian ornithological literature, however, this dove is called the "Little Brown Dove" which, for the above reason should be changed to "Laughing Dove".

Streptopelia senegalensis cambayensis (Gmelin).

(The Indian Laughing Dove or Indian Little Brown Dove.)

1789. *Columba cambayensis*, Gmelin, *Syst. Nat.* I, p. 779. ("Cambaya", *i.e.*, Gulf of Cambay, W. coast of India).
1849. *Turtur senegalensis* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 237, No. 1438.
1928. *Streptopelia senegalensis cambayensis* and *S. s. ermanni* (part), Stuart Baker, *Faun. Brit. Ind., Birds* (2nd. ed.) V, pp. 246, 247.
1937. *Streptopelia senegalensis cambayensis*, Peters, *Check list Birds World* III, p. 99.

Streptopelia senegalensis cambayensis is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex	Locality	Date.	Collector or Donor.	Measurements (mm.). W.	T1.	Ts.	C.
17313	♂	Gilgit (Kashmir)	Jan. 27, 1880	Dr. J. Scully.	125	116	..	12·5
4065	(?)	Simla (Punjab).	(?)	Dr. F. Stoliczka.	120	..	22	13
18317	(?)	Ahmadabad (Gujrat).	(?)	H. E. M. James.	126	122	20	15
4066	(?)	Manbhum (E. Bihar)	(?)	"Mus. Coll."	121	(117)	21	13
4067	(?)	Manbhum (E. Bihar)	(?)	"Mus. Coll."	110	..	19	14
4068	♂	S. E. Berar, West of Chanda (Central Provinces).	Jan. 18, 1870	Mr. W. T. Blanford.	123	(111)	20	15
11044	♀	"Bhoura" (Bavda), 2,200 ft. (Kolhapur State, Bombay Presidency).	Mar. 26, 1878	Surg. J. Armstrong.	123	..	18	14
18441	♂	Near Bangalore (Mysore State).	(?)	"Mus. Coll., Jaffa."	124	114	20	13·5
18542	♀	Near Bangalore (Mysore State).	(?)	"Mus. Coll., Jaffa."	124	113	20	14
9933	♀	Bampur, 2,000 ft. (Baluchistan).	Apr. 5, 1872	Mr. W. T. Blanford.	127	117	21	13·5

Remarks.- The two Baluchistan skins, Nos. 9933 and 9934, are indistinguishable from the rest, and are *cambayensis*. not *ermanni*.

Distribution. – " Eastern Persia, Baluchistan and the greater part of India " (Peters).

Genus **Oenopopelia** Blanford.

Oenopopelia tranquebarica (Herman).

This, the only species of the genus, ranges over the whole of S. E. Asia, *e.g.*, from E. Afghanistan (Meinertzhagen, 1938, p. 710) and Sind in the west, through the whole of India and Ceylon, *via* N. E. Tibet, Yunnan, Burma and the Andaman Islands to Siam (not the Malay Peninsula), Indo-China, the whole of China (straggling up to Japan) to the northern Phillippines, Hainan and Formosa ; once also found on the coast of British N. Borneo (Hartert & Steinbacher, 1936, p. 160). Peters (1937, p. 97) admits three subspecies all of which occur within the Indian limits.

Oenopopelia tranquebarica tranquebarica (Herman).

(The Indian Red Turtle-Dove.)

1804. *Columba tranquebarica*, Herman, *Obs. Zool.*, p. 200. (" Tranquebaria ", India.)
1849. *Turtur humilis* (part). Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 236, No. 1432.
1928. *Oenopopelia tranquebarica tranquebarica*, Stuart Baker, *Faun. Brit. Ind, Birds* (2nd ed.) V, p. 250.
1937. *Streptopelia tranquebarica tranquebarica*, Peters, *Check-list Birds World* III, p. 97.

Oenopopelia tranquebarica tranquebarica is represented in the collection of the Indian Museum by the following skins :

Reg. No.	Sex.	Locality.	Date	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
4051	♂	Agra (United Provinces).	(?)	" Riddell Mus."	131	99	20	13
4052	♂	Agra (United Provinces).	(?)	" Riddell Mus."	134	(94)	18	13·5
4054	♂	Nagpur (Central Provinces).	(?)	Mr. W. T. Blanford.	131	98	19	14
4057	*♂	S. E. Berar.	(?)	Mr. W. T. Blanford	137	..	19	13
18546	♀	Near Bangalore (Mysore State).	(?)	" Mus. Coll., Jaffa."	135	99	19	14

Distribution.—" India from Sind and the Punjab east to western Nepal, Bihar and Bengal " (Peters).[1]

[1] Layard (1854, p. 60) once recorded a small colony of " *Turtur humilis* " breeding in the Jaffna Peninsula in Ceylon. This is the sole record from Ceylon. Stuart Baker (1928, p. 250), Wait (1931, p. 298) and Phillips (1941, pp. 207, 211) refer Layard's Ceylon record to *O. t. tranquebarica* and not to *O. t. humilis*, but I cannot say how far they are right in doing so.

For the following reasons, the western limit given above needs extension. Whistler (1928, p. 308) stated that it occurs in the North-West Frontier Province. Later, Whilstler (1930, p. 271) recorded typical *tranquebarica* as a summer visitor in the Rawalpindi District (extreme N. W. Punjab). Meinertzhagen (1938, p. 710) observed this dove (subspecies not given, but presumably *S. t. tranquebarica*) at Jalalabad in E. Afghanistan on May 31st. The range should, therefore, be extended as far west as Jalalabad.

Oenopopelia tranquebarica murmensis Hartert.

(The Sikkim Red Turtle-Dove.)

1920. *Oenopopelia tranquebarica murmensis*, Hartert, *Vogel paläarkt. Fauna* II, p. 1499. (Eastern Himalayas, *i.e.*, Nepal and Sikkim.)

1928. *Oenopopelia tranquebarica murmensis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 252.

1937. *Streptopelia tranquebarica murmensis*, Peters, *Check-list Birds World* III, p. 97.

Oenopopelia tranquebarica murmensis is represented in the collection of the Indian Museum by the following skins :

Reg. No.	Sex.	Locality	Date	Collector or Donor.	Measurements (mm.).			
					W.	[illegible]	Tl.	C.
26515	[illegible]	Jalpaiguri District (N. Bengal)	Feb. 27, 1931	Mr. C. M. Inglis	146	113	90	11
26516	[illegible]	Jalpaiguri District (N. Bengal).	Feb. 11, 1929	Mr. C. M. Inglis	[illegible]	..	91	11

Distribution.- "Eastern Nepal, Sikkim, and Assam north of the Brahmapootra " (Peters).

The two Indian Museum skins from the Jalpaiguri District (N. Bengal) would appear to be nearer to *murmensis* than to *tranquebarica*, but I have no typical *murmensis* to compare with.

Oenopopelia tranquebarica humilis (Temminck).

(The Burmese Red Turtle-Dove.)

1824. *Columba humilis*, ♀, Temminck, *Pl. Color d'Oiseaux*, livr. 44, p. 287 and pl. 259 (but not pl. 258). (Bengal, India ; and Luzon Is., Philippines.) Although labelled as ♀, the specimen figured in pl. 259 is really ♂.

1849. *Turtur humilis* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 236, No. 1432.

1928. *Oenopopelia tranquebarica humilis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 251.

1937. *Streptopelia tranquebarica humilis*, Peters, *Check-list Birds World* III, p. 97.

Oenopopelia tranquebarica humilis is represented in the collection of the Indian Museum by the following skins:—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor	Measurements (mm.)			
					W.	B.	Tr.	C.
24585	(♂)	Sylhet (Assam) ..	(?)	C. B. Antram	133	89	19	14
24577	♀	S. Sylhet (Assam) .	(?)	C. B. Antram.	128	88	20	11
24576	♀	S. Sylhet (Assam) ..	(?)	C. B. Antram.	132	.	18	13
8268	♂	Thayetmyo (Central Burma).	Dec. 14, 1871	Dr F. Stoliczka.	145	98	20	13
8269	♀	Thayetmyo (Central Burma).	Dec. 14, 1871	Dr. F. Stoliczka	133	93	20	..
8270	♀	Thayetmyo (Central Burma).	(?)	Dr. F. Stoliczka.	136	91	21	14
25940 (Mounted in gallery.)	?	"Aberdeen" (Andamans).	1930	Zool. Survey of India.	(137)	(98)	21	16
20910	♂	Foochow (E. China).	May 1891	C. B. Rickett.	115	97	20	14·5
20911	(♀)	Foochow (E. China).	Apr. 1891	C. B. Rickett.	133	91	52	15
20912	(♀)	Foochow (E. China).	Apr. 1891	C. B. Rickett.	139	91	20	13
4050	(♂)	S. W. Formosa ..	(?)	R. Swinhoe.	115	93	21	11
4055	(♀)	S. W. Formosa ..	(?)	R. Swinhoe.	134	82	22	13
26537[1]	(♀)	(?)	(?)	(?)	131	..	21	13·5

[1] On the label this specimen bears the Indian Museum Registered No. 21622, and the following additional particulars: "*Turtur humilis*, S. Sylhet". However, in the I. M. Bird Register No. IV of the Zoological Survey of India (Indian Museum), the bird listed against the above number is the Roller "*Eurystomus orientalis*, ♀, S. Sylhet, Purchased (C. B. Antram)", and, corresponding to this, there is in the Indian Museum collection a specimen of *E. orientalis* bearing a similar label and number. The data given on the label of the Dove have, therefore, to be rejected, and the Dove has been given a new Reg. No., 26537.

Distribution.—"Greater part of southeastern Asia from northeastern Tibet and northern China, south to Assam, Burma, Andaman Islands, Siam, Indochina and the northern Philippines. Migratory in the northern part of its range, locally resident in the southern part" (Peters).

Subfamily *Macropygiinae*.

Genus **Macropygia** Swainson.

Macropygia unchall (Wagler).

The species ranges from Kashmir in the west and along the Himalayas to the hills of Burma extending to N. Siam, French Indo-China, S. E. China and the Island of Hainan. South it extends *via* the Malay Peninsula to Sumatra, Java and Lombok. Peters (1937, pp. 75, 76) admits three subspecies of which one, *tusalia*, occurs within the Indian limits.

Macropygia unchall tusalia (Blyth)

(The Bar-tailed Cuckoo-Dove.)

1843[1]. *Columba tusalia* "Hodgson" Blyth, *Journ. Asiat. Soc. Bengal* XII, Pt. 2, p. 936. (Darjeeling, N. Bengal.)

1849. *Macropygia leptogrammica*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 235, No. 1421.

1928. *Macropygia unchall tusalia*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd. ed.) V, p. 253.

1937. *Macropygia unchall tusalia*, Peters, *Check-list Birds World* III, p. 75.

Macropygia unchall tusalia is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex	Locality	Date	Collector or Donor	Measurements (mm.).			
					W.	T.	T.	C.
4012	(♂)	Darjeeling (N. Bengal)	(?)	T. R. Doucett	195	199	25	15
4013	(♂)	Darjeeling (N. Bengal)	(?)	T. R. Doucett	196	193	26	..
4007	(♀)	Darjeeling (N. Bengal)	(?)	T. R. Doucett	181	191	22	15
26195		Darjeeling (N. Bengal)	1843	Mrs. Saxon (Asiat. Soc. Bengal)	191		26	16
4016	(♀)	Darjeeling Terai (N. Bengal).	(?)	Dr. Anderson.	181	(186)	21	16·5
4015	(Juv. ♂?)	Darjeeling Terai (N. Bengal).	(?)	Dr. Anderson.	191	216	25	16
4017	( )	Darjeeling Terai (N. Bengal)	(?)	Dr. Moller.	193	170	2[illegible]	15
26191	[illegible]	Manipur State (E. Assam)	Feb. 11, 1936	Zool. Survey of India.	177	174	21	16

Remarks. No. 26195 (Darjeeling) was listed by Blyth (1849, p. 235, No. 1421 *B*) as *Macropygia leptogrammica* Temminck.

Distribution. "The Himalayas from Kashmir and Garhwal east to Assam and perhaps to western Szechuan, south in the hills to Burma and the Shan States" (Peters).

De Schauensee (1934, p. 273) recently secured in January immature females, suggesting breeding, at Chieng Dao (1,500 feet) in N. W. Siam; he found the bird there "not uncommon".

Macropygia rufipennis Blyth.

(The Nicobar Cuckoo-Dove[2].)

1846. *Macropygia rufipennis*, Blyth, *Journ. Asiat. Soc. Bengal* XV, p. 371. (Southern Nicobars.)

1849. *Macropygia rufipennis*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 234, No. 1422.

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[1] Stuart Baker (1928, p. 253) wrongly gives the first reference as: "*Coccyzura tusalia* Hodgs., J. A. S. B., XIV, p. 809 (1843) (Nepal)." The whole reference is wrong, even apart from the question of priority—volume, page, year and author are all confused, and the above reference does not exist.

Stuart Baker (1930, p. 442) is again wrong in giving Blyth's reference. He wrongly gives *Macropygia* as a subgenus of *Columba*. Blyth wrote: "*Columba* (*Macropygia*, Swainson) [*tusalia*, Hodgson.]", no doubt meaning that his *Columba tusalia* would be referable to genus *Macropygia* Swainson. The date is clearly 1843, not "1843-44" as given by Stuart Baker.

[2] This name is preferable to "The Andaman Cuckoo-Dove" employed by Stuart Baker (1928, p. 255) for, the type-locality is the Nicobars, not the Andamans.

1928. *Macropygia rufipennis*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 233.
1937. *Macropygia rufipennis*, Peters, *Check-list Birds World* III, p. 80.

Macropygia rufipennis is represented in the collection of the Indian Museum by the following skins:

Reg. No.	Sex.	Locality	Date	Collector or Donor	Measurements (mm.)			
					W.	T.	Ts.	C.
26191 (Lecto-type)	(♀)	Nicobars	(1846)	Capt. Lewis & Rev. J. Barbe (Asiat. Soc. Bengal)	188	191	29	17
26192 (Syn-type)	(♂)	Nicobars	(1846)	Capt. Lewis & Rev. J. Barbe (Asiat. Soc. Bengal)	19[illegible]	20[illegible]	(28)	16
26193 (Syn-type)	( )	Nicobars	(1846)	Capt. Lewis & Rev. J. Barbe (Asiat. Soc. Bengal)	1[illegible]7		28	(19)
4008	(♂)	Andamans	(?)	Dr. G. E. Dobson	181	18[illegible]	21[illegible]	
4009	(♂)	Andamans	(?)	Dr. G. E. Dobson	191	(188)	27	16
4010	(♂)	Andamans	(?)	Dr. G. E. Dobson	19[illegible]	216	27	17
4011	(♂)	Andamans	(?)	Dr. G. E. Dobson	190	17[illegible]	23	16

Remarks. Each of the three skins, Nos. 26191, 26192 and 26193, bears the label " Type No. 1122 *Macropygia rufipennis* Blyth, *A. B. C.*, Nicobars, Capt. Lewis and Rev. J. Barbe, 1846, A. S. B.". Obviously they are the three specimens listed by Blyth (1849, p. 231, No. 1122, *A, B, C*) as *Macropygia rufipennis* (specimens from Nicobar Islands, presented by Capt. Lewis & Rev. J. Barbe, 1846). Presumably also Blyth gave his original description of the species (1846, pp. 371–372) from one of these three specimens. They may, therefore, be regarded as Syntypes. Among these No. 26191 is the best preserved, and I, therefore, select it as the Lectotype.

In Nos. 4009 and 4011 the tail is markedly shorter than the wings; the specimens look normal in other respects.

I cannot find any difference between birds from the Andamans and the Nicobars.

Distribution.— " Andaman and Nicobar Islands " (Peters).

Family COLUMBIDAE.

Subfamily *GEOPELIINAE*.

Genus **Geopelia** Swainson.

Geopelia striata (Linnaeus).

The species extends from southern Tenasserim in Burma, through the Malay Peninsula and the East Indies to the whole of Australia. Peters (1937, pp. 100, 101) admits five subspecies of which *striata* alone is found within the Indian limits.

Geopelia striata striata (Linnaeus).

(The Barred Ground-Dove.)

1766. *Columba striata*, Linnaeus, *Syst. Nat* (12th ed.) I, p. 282. (" India orientali" ; restricted to Malacca by Chasen, 1935, and to Java by Peters, 1937.)
1849. *Geopelia striata*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 235, No. 1428.
1928. *Geopelia striata striata*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 258.
1937. *Geopelia striata striata*, Peters, *Check-list Birds World* III, p. 100.

Geopelia striata striata is represented in the collection of the Indian Museum by the following skins :

Reg No	Sex	Locality	Date	Collector or Donor	Measurements (mm.) W	T.	Ts	C
4069	(?)	Wellesley Prov. (Malay Penin.)	1870	(Purchased.)	98	113	20	13
26561	♀	Nong Koh (Ghulo, Peninsular Siam)	Jan. 3, 1918	Raffles Mus. Singapore	100	105	19	13
21004	(Juv.)	Bred in aviary at Calcutta	1902	Major A. Alcock				..

Distribution. " Southern Tenasserim southward over the Malay Peninsula ; Luzon and occasionally other islands in the Philippines ; Borneo Sumatra, Java and Lesser Sunda Islands to Lombok. Introduced into Madagascar and other islands in the western Indian Ocean ; St. Helena ; Hawaiian Islands ; its presence in southern Celebes and Amboina is believed to be due to introduction also " (Peters).

Subfamily *Phabinae*.

Genus **Chalcophaps** Gould.

Chalcophaps indica (Linnaeus).

The species ranges from India *via* Malaya, S. China and the East Indies to Australia. Peters (1937, pp. 114, 115) accepts ten subspecies of which three, *indica*, *maxima* and *robinsoni*, occur within the Indian limits.

Chalcophaps indica indica (Linnaeus).

(The Indian Emerald or Bronze-winged Dove.)

1758. *Columba indica*, Linnaeus, *Syst. Nat.* (10th ed.) I, p. 164. (" India orientali " ; restricted to Calcutta by Stuart Baker, 1928, p. 215.)
1849. *Chalcophaps indicus* (part), Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 237, No. 1440.
1928. *Chalcophaps indica indica* (part), Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 215.
1937. *Chalcophaps indica indica*, Peters, *Check-list Birds World* III, p. 114.

Chalcophaps indica indica is represented in the collection of the Indian Museum by the following skins :-

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
13520	(♂)	Malacca (Malay Penin.).	(?)	Bengal Economic Mus.	140	(96)	25	15
13468	(♀)	Malacca (Malay Penin.)	(?)	Bengal Economic Mus.	142	95	27	15
4077	♂	Welesley Province (Malay Penin.).	1870	Asiat. Soc. Bengal. (Purchased.)	145	97	26	17
4074	♀	Welesley Province (Malay Penin.).	(?)	Asiat. Soc. Bengal. (Purchased.)	131	93	25	15
12919	♂	Pilai (Mergui, S. Burma).	Mar. 4, 1882	Dr J. Anderson.	134	(84)	27	16·6
12920	♂	Pilai (Mergui, S. Burma).	Mar. 5, 1882	Dr. J. Anderson.	147	(105)	28	15
9088	♀	Katha (Upper Burma).	Jan. 19, 1868	Dr. J. Anderson.	147	(98)	27	16
9070	(Juv. ♂)	Cachar (Assam). ..	(?)	" Mus Coll."	[135	87	26	19]
4078	♂	Darjeeling (N. Bengal).	Apr. 3, 1869	Mr. Muller.	144	95	26	16
25675	♂	Ranaghat (Nadia District, Bengal).	Aug. 20, 1927	Mr. A. Rahim.	145	104	26	17
4071	♀	Bengal.	(?)	(?)	139	95	25·5	16
18110	♂	Shevaroy Hills, (Salem District, Madras Presidency).	May 16, 1869	W. Daly.	141	95	25	16
23939	(♀)	Talayal (Travancore).	Jan. 1892	Trivandrum Mus.	146	99	26	17
4075	(♀)	Travancore. ..	(?)	Asiat. Soc., Bengal. (Purchased.)	138	94	25	(17)

Remarks.—No. 23939 is labelled as a ' ♂ " by the collector, but has the plumage of a ♀. Stuart Baker (1928, p. 216) gives the wing-length as 146-161 mm. In the Indian Museum collection, some birds have very much shorter wings, thus: No. 4071, ♀, Bengal, 139 mm.; No. 12919, ♂, Pilai (Mergui), 134 mm.; No. 4074, ♀, Welesley Province (Malay Penin.), 131 mm.

Distribution.—" Kashmir, Bengal, Assam, Tonkin[1], Hainan and the Riu Kiu Islands south over India, Burma, Malay Peninsula, Indochina, the Philippines, Borneo and Celebes to the Great Sunda Islands, and the Lesser Sunda chain to Alor and Sumba; Moluccas and extreme western Papuan Islands (Gebe and Koffiao) " (Peters).

The following remarks are necessary with regard to the Indian range :—Ticehurst (1930, p. 477) has pointed out that the record of its occurrence in Kashmir seems to be incorrect. On the western coast it extends from Travancore to the Salsette Island near Bombay. On the eastern side it is said to occur from Bihar and Orissa, south to the Nelliampathy and the Shevaroy hills, and is fairly common all over Peninsular India.

[1] " Recorded from Yunnan and western Szechuan by David; it has not been taken in these provinces by collectors in the present century " (Peters).

Chalcophaps indica maxima Hartert.

(The Andaman Emerald or Bronze-winged Dove.)

1928. *Chalcophaps indica indica* (part), Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 215.
1931. *Chalcophaps indica maxima*, Hartert, *Orn. Monatsb.* XXXIX, p. 145. (Golapabung, S. Andamans.)
1937. *Chalcophaps indica maxima*, Peters, *Check-list Birds World* III, p. 114.

Chalcophaps indica maxima is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex	Locality.	Date.	Collector or Donor	Measurements (mm.).			
					W.	Tl.	Tr.	C.
4072	(Juv. ?) ♂	Andamans. ..	(?)	Dr. G. E. Dobson.	[153	(100)	31	19]
4073	(Juv.)	Andamans. ..	(?)	Dr. G. E. Dobson.	[143	86	29	18]

Remarks.—No. 4072 is labelled as a " ♀ " by the collector, but has the plumage of a juvenile ♂—the male plumage is quite clear on the head, mantle and breast, but the white patch on the wing is not yet well developed.

Distribution.—" Andaman Islands " (Peters).

Chalcophaps indica robinsoni Suart Baker.

(The Ceylon Emerald or Bronze-winged Dove.)

1928. *Chalcophaps indica robinsoni*, Stuart Baker, *Bull. Br. Orn. Club* XLVIII, p. 58. (Cocawatte Estate, Ceylon.)
1928. *Chalcophaps indica robinsoni*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 217.
1937. *Chalcophaps indica robinsoni*, Peters, *Check-list Birds World* III, p. 114.

Chalcophaps indica robinsoni is represented in the collection of the Indian Museum by the following skins :—

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
26553	♂	Higara (or Hujara) (South Province, Ceylon) [*Wet Zone*].	May 20, 1932	Colombo Mus., Ceylon.	137	(90)	25	15
26552	♀	Uduwama (South Province, Ceylon) [*Wet Zone*].	Aug. 21, 1905	Colombo Mus., Ceylon.	137	87	25	16

Distribution.—" Ceylon " (Peters).

Subfamily *CALAENADINAE*.

Genus **Caloenas** G. R. Gray.

Caloenas nicobarica (Linnaeus).

This, the only species of the genus, occurs in the greater part of the Indo-Australian region from the Nicobars and the Mergui Archipelago

eastward to the Solomon Islands. Peters (1937, p. 139) admits two subspecies; of these, only *nicobarica* occurs within the Indian limits.

Caloenas nicobarica nicobarica (Linnaeus).

(The Nicobar Pigeon.)

1758. *Columba nicobarica*, Linnaeus, *Syst. Nat.* (10th ed.) I, p. 164. (Nicobar Islands.)
1849. *Caloenas nicobarica*, Blyth, *Catal. Birds Mus. Asiat. Soc. Bengal*, p. 238, No. 1444.
1928. *Caloenas nicobarica nicobarica*, Stuart Baker, *Faun. Brit. Ind., Birds* (2nd ed.) V, p. 213.
1937. *Caloenas nicobarica nicobarica*, Peters, *Check-list Birds World* III, p. 139.

Caloenas nicobarica nicobarica is represented in the collection of the Indian Museum by the following skins: -

Reg. No.	Sex.	Locality.	Date.	Collector or Donor.	Measurements (mm.).			
					W.	Tl.	Tr.	C.
5941	♂	Nicobars. .	Oct. 7, 1870	W. Rutledge.	251	103	15	25
6875	(?)	Nicobars. ..	July 1873	H. D. Cooper.	225	(97)	18	25
5940	♀	Nicobars. .	Sept. 22, 1871	Lady Mayo.	215	93	17	23
5942	♂	Nicobars. ..	Feb 27, 1871	W. Rutledge.	217	91	18	26
26473	(Juv.)	Nicobars ..	1846	Capt. Lewis.	|210	.	11	22|
1094	♀	Andamans. .	July 2, 1867	(Purchased.)	241	91	13	26
18346	♀ (Juv.)	Andamans. .	(?)	G. H. Booley.	|219	..	15	21|
14094	(?)	Gregory Is. (Mergui Archipelago, S. Burma).	(?)	Dr. G. M. Giles.	255	95	19	25
14095	(?)	Gregory Is. (Mergui Archipelago, S. Burma).	(?)	Dr. G. M. Giles.	215	79	50	22
23159	♂	(Purchased at Calcutta.)	(?)	Mr. F. Finn.	199	77	13	23
25975 (Mounted in gallery.)	♂	(?)	Nov. 27, 1929	Zool. Gardens, Calcutta.	252	96	(13)	23

Remarks.—No. 26473 was listed by Blyth (1849. p. 238, No. 1444 *C*) as "young (black-tailed....)". Blyth (1846, p. 371), Robinson & Chasen (1936, p. 65), and others have stated that young birds have a greenish-black tail, instead of white as in adults. In the Indian Museum collection Nos. 26473 and 18346 have greenish-black tails, and are, therefore, young forms—in all others the rectrices are white.

Distribution.—"The greater part of the Indo-Australian region from the Nicobars and the Mergui Archipelago eastward over the Sunda Islands, Philippines, Celebes, Moluccas, Papuan Islands, New Guinea, Admiralty Islands, D'Entrecasteaux Archipelago; Trobriand Islands, and Louisiades, to the Solomon Islands. Wherever found occurs only on the small islands and on the islets off the larger land masses. Migrates between various groups of islands" (Peters).

(b) *Extra-Indian Species.*

The following extra-Indian species and subspecies are listed in the present Catalogue :—

Treronidae.

Treroninae.

Dendrophassa Glog.

D. olax (Temm.), p. 350.

Vinago Cuv.

V. waalia (Gmel.), p. 350.
V. australis (Linn.) (subsp. ?), p. 350.

Treron Vieil.

T. curvirostra nasica Schl., p. 350.

Ptilinopinae.

Ptilinopus Swain.

P. jambu (Gmel.), p. 350.
P. perousii perousii Peale, p. 350.
P. ponapensis (Finsch) (subsp. ?), p. 351.
P. superbus superbus (Temm.), p. 351.
P. bellus (Sclat.), p. 351.
P. solomensis speciosus (Schl.), p. 351.
P. melanospila ?melanauchen (Salvad.), p. 351.
P. pectoralis (Wagl.) (subsp. ?), p. 351.
P. geelvinkiana (Schl.), p. 351.

Megaloprepia Reichenb.

M. magnifica puella (Less.), p. 351.

Duculinae.

Muscadivora Schl.

M. aenea (Linn.) (subsp. ?), p. 351.
M. aenea (Linn.) (subsp. ?), p. 351.
M. perspicillata (Temm.) (subsp. ?), p. 352.

Hemiphaga Bonap.

H. novaeseelandiae (Gmel.) (subsp. ?), p. 352.

Columbidae.

Columbinae.

Columba Linn.

C. livia livia Gmel., p. 352.
C. oenas oenas Linn., p. 352.
C. oenas yarkandensis Butur., p. 353.
C. albitorques Rüpp., p. 353.
C. palumbus palumbus Linn., p. 353.
C. guinea dilloni (Bonap.), p. 353.
C. norfolciensis Lath., p. 353.

Streptopelia Bonap.

S. orientalis (Lath.) (subsp. ?), p. 353.
S. lugens lugens (Rupp.), p. 353.
S. decaocto stoliczkae Hume, p. 354.
S. roseogrisea arabica (Neum.), p. 354.
S. semitorquata semitorquata (Rüpp.), p. 354.
S. chinensis chinensis (Scop.), p. 354.
S. senegalensis senegalensis (Linn.), p. 354.

Macropygiinae

Macropygia Swain.

M. ruficeps malayana Chas. & Kl., p. 354.
M. ruficeps (Temm.) (subsp. ?), p. 354.
M. phasianella phasianella (Temm.), p. 354.

Claravisidae.

Geopeliinae.

Geopelia Swain.

G. striata maugeus (Temm.), p. 355.
G. striata placida Gould, p. 355.
G. striata tranquilla Gould, p. 355.

Phabinae.

Oena Swain.

O. capensis capensis (Linn.), p. 355.

Turtur Bodd.

T. abyssinicus abyssinicus (Sharpe), p. 355.

Chalcophaps Gould.

C. indica chrysochlora (Wagl.), p. 356.

Phaps Selby.

P. chalcoptera chalcoptera (Lath.), p. 356.
P. chalcoptera (Lath.) (subsp. ?), p. 356.
P. elegans neglecta Math., p. 356.

Ocyphaps Gray.

O. lophotes (Temm.), p. 356.

Geophaps Gray.

G. scripta (Temm.) (subsp. ?), p. 356.

Geotrygoninae.

Leucosarcia Gould.

L. melanoleuca (Lath.), p. 356.

Family TRERONIDAE.

Subfamily *TRERONINAE*.

Genus **Dendrophassa** Gloger.

Dendrophassa olax (Temminck).

(The Little Green Pigeon.)

Five skins—three from the Wellesley Province and Malacca in the Malay Peninsula, and two from Sarawak, Borneo.

Genus **Vinago** Cuvier.

Vinago waalia (Gmelin)[1].

(Bruce's Fruit or Green Pigeon.)

Five skins from various places in Eritrea. Collected by Mr. W. T Blanford in 1868 and listed by him (1870, p. 418) as *Treron abyssinica*.

Vinago australis (Linnaeus) (subsp. ?).

One skin from Madagascar.

Genus **Treron** Vieillot.

Treron curvirostra nasica Schlegel.

(The Borneo Lesser Thick-billed Green Pigeon.)

Three skins from Sarawak, Borneo.

Subfamily *PTILINOPINAE*.

Genus **Ptilinopus** Swainson.

Ptilinopus jambu (Gmelin).

(The Pink-headed Fruit Dove.)

Thirteen skins—six from the Malay Peninsula, one from Banguara in Peninsular Siam (July 8, 1926), and six from unknown localities.

Peters (1937, p. 38) does not include Siam in its range. Besides other records, there is the above skin from Peninsular Siam in the Indian Museum.

Ptilinopus perousii perousii Peale.

Two skins, Nos. 26479 and 26480, from Samoa (Navigator) Islands, S. Pacific; they are Nos. 1397*A* and *B* respectively of Blyth (1849, p. 231). Blyth regarded *A* as adult and *B* as young; actually both are adults—*A* is ♀ and *B* ♂.

[1] Peters (1937, p. 22) assigns the authorship of the species to F. A. A. Meyer 1793, but Gmelin 1791 has priority.

Ptilinopus ponapensis (Finsch) (subsp. ?).

One skin, No. 26478, from Ladrone (Marianne) Islands, S. Pacific. It was listed by Blyth (1849, p. 231, No. 1396 *A*) who wrongly identified it as *P. purpuratus* Temminck.

Ptilinopus superbus superbus (Temminck).

(The Purple-crowned Fruit Dove.)

Three skins from New South Wales, Australia.

Ptilinopus bellus (Sclater).

One ♂ from Hatam, Arfak, Dutch New Guinea.

Ptilinopus solomensis speciosus (Schlegel).

One ♂ from Korido, Musauri or Mysori Is., Geelvink Bay, New Guinea.

Ptilinopus melanospila ?melanauchen (Salvadori).

One ♂ from Java.

Ptilinopus pectoralis (Wagler) (subsp. ?).

One ♀ from Amberbaken, Dutch New Guinea.

Ptilinopus geelvinkiana (Schlegel).

One ♂ from Pulo-Manin Is., Geelvink Bay, New Guinea.

Genus **Megaloprepia** Reichenbach.

Megaloprepia magnifica puella (Lesson).

One ♂ from Amberbaken, New Guinea.

Subfamily *DUCULINAE*.

Genus **Muscadivora** Schlegel.

Muscadivora aenea (Linnaeus) (subsp. ?).

No. 23811 from an unknown locality. Wing 213, tail 153, tarsus 34, culmen 26 mm. In its wing-length and certain other characters it resembles *M. a. pusilla*, but differs in the virtual absence of the vinous colour on the abdomen and the forebody. The under tail-coverts are chestnut.

Muscadivora aenea (Linnaeus) (subsp. ?).

No. 26471 from an unknown locality. Donor: "Batavian Society", 1845. Wing 219, tail 145, tarsus 27, culmen 23 mm.

The skin closely resembles *M. a. sylvatica* except that the grey of the forebody and venter is rather darker and with hardly any vinaceous; the wing-length is also slightly shorter.

It was listed by Blyth (1849, p. 231, No. 1400 *A*) as "*Carpophaga ianthiana* (?)". Blyth wrote: "Syn. *Col. ianthiana* (?)...Temminck (*Pl. Col.* 503)"; no locality was given. It is not clear why Blyth quoted this synonymy even with a query. The specimen figured by Temminck, *Pl. Color d' Oiseaux* IV, 1823, pl. 503 as "*Colombe violette*", and described by him on p. 257 under *Columba janthiana* (not *ianthiana*) Temm., has no resemblance to the specimen in the Indian Museum Besides, Temminck's specimen came from Japan where *M. aenea* does not occur.

Muscadivora perspicillata (Temminck) (subsp. ?).

One skin from an unknown locality.

Genus **Hemiphaga** Bonaparte.

Hemiphaga novaeseelandiae (Gmelin) (subsp. ?).

Two skins from the Bank Peninsula, New Zealand.

Family COLUMBIDAE.

Subfamily *COLUMBINAE*.

Genus **Columba** Linnaeus.

Columba livia livia Gmelin.

(The Blue Rock Pigeon.)

Four skins—one from "Europe", two from England; and a fourth, No. 26567, ("L. Bengal", *errore* ?) is mounted in the gallery and bears the label: "1417 *D*....*Columba intermedia* Strickl.". Under this number, Blyth (1849. p. 234) wrote: "...no white on rump". Actually there is a white rump about 55 mm. broad and the specimen resembles *C. l. livia*. Evidently Blyth's labelling was faulty.

There is also a specimen mounted in the gallery and bearing the label "1417*A* ... a variety of domestic pigeon"; this is evidently the specimen listed by Blyth (*loc. cit.*, No. 1417 *A*). It is about twice the size of the normal wild bird. Colour: head and neck metallic green tinged with copper; remaining portions white speckled with black.

According to Stuart Baker (1928, p. 220), *C. livia livia* is a straggler in N. W. India. But Ticehurst (1930, p. 477) has given reasons to show that its range does not extend to India.

Columba oenas oenas Linnaeus.

(The European Stock-Pigeon.)

Three skins—two from England and one ♀, No. 14527, from Karagh (about 34° 50′ N. lat. and 61° 45′ E. long.) in N. W. Afghanistan

(collected by Surgeon J. Aitchison, Afghan Boundary Commission, Nov. 28, 1884). The Afghanistan skin is indistinguishable from the two skins from England, but is separable from the Yarkand skins, *yarkandensis*, in that the latter are paler and larger. The Afghanistan skin measures: wing 219, tail 123, tarsus 32, culmen 18 mm.

Columba oenas yarkandensis Buturlin.

Four skins—three from Yarkand in E. Turkestan and one ♀, No. 14299, from "Chahar Shamba" (= ?Chahar Sada) in N. W. Afghanistan (collected by Capt. Yate, 1886). The Afghanistan skin measures: wing 223, tail 130, tarsus 30, culmen 17 mm. It is inseparable from the Yarkand skins.

Columba albitorques Rüppell.

(The White-collared Pigeon.)

Two skins from Senafe, 7,500 feet, in Tigre, S. Eritrea. Collected by Mr. W. T. Blanford in 1868.

Columba palumbus palumbus Linnaeus.

(The European Wood-Pigeon or Ring-Dove[1].)

Two skins from England.

Columba guinea dilloni (Bonaparte).

(The Abyssinian Speckled Pigeon.)

Five skins—three from Tekoonda, Halai and Badraket in Tigre in N. Abyssinia, and two from Mahbar on R. Lebka in Habab, Eritrea. Collected by Mr. W. T. Blanford in 1868.

Columba norfolciensis Latham.

(The Australian White-headed Fruit Dove.)

Two skins from New South Wales, Australia.

Genus **Streptopelia** Bonaparte.

Streptopelia orientalis (Latham) (subsp. ?).

One juv. ♀, unknown locality.

Streptopelia lugens lugens (Rüppell).

(The Abyssinian Dusky Dove or Abyssinian Pink-breasted Turtle Dove.)

Four skins from the Tigre Province in S. Eritrea and on the Eritrea-Abyssinia frontier. Collected by Mr. W. T. Blanford in 1868.

[1] The name "Ring Dove" is now used for *Streptopelia decaocto* (Frivaldszky).

Streptopelia decaocto stoliczkae (Hume).

(The Kashgar Ring-Dove.)

1874. *Turtur Stoliczkae*, Hume, *Str. Feath.* II, p. 519. (Kashgar, E. Turkestan.)

Five skins from E. Turkestan—two from Kashgar and three from Yarkand. They give the following wing-length: -3♂♂: 176-187; 2♀♀: 169-175 mm. No. 26534 (Kashgar) is the Holotype and is in good condition. After Hume (1874), the type-specimen was re-described by Sharpe (1881, p. 117) and recently by Roonwal (1940, p. 141).

Streptopelia roseogrisea arabica (Neumann).

(The Arabian Pink-headed Dove.)

Four skins from Eritrea, collected by Mr. W. T. Blanford in 1868 and described by him (1870, p. 417) as *Turtur albiventris*. Wing—3♂♂: 154-161; 1♀: 155 mm.

Streptopelia semitorquata semitorquata (Rüppell).

(The Half-collared or Red-eyed Dove.)

Four skins from Eritrea and N. Abyssinia, collected by Mr. W. T. Blanford in 1868.

Streptopelia chinensis chinensis (Scopoli).

(The Chinese Spotted Dove.)

Three skins from E. China—two from Foochow and one from Amoy.

Streptopelia senegalensis senegalensis (Linnaeus).

(The Laughing Dove.)

Four skins from Eritrea, collected by Mr. W. T. Blanford in 1868.

Subfamily *MACROPYGIINAE*.

Genus **Macropygia** Swainson.

Macropygia ruficeps malayana Chasen & Kloss.

(The Little Malaya Cuckoo-Dove.)

One skin from the Wellesley Province, Malay Peninsula.

Macropygia ruficeps (Temminck) (subsp. ?).

One skin, unknown locality.

Macropygia phasianella phasianella (Temminck).

One ♀ from New South Wales, Australia.

Family Claravisidae.

Subfamily *Geopelinae.*

Genus **Geopelia** Swainson.

Geopelia striata maugeus (Temminck).

Two skins from the Timor Island, E. Indies.

Geopelia striata placida Gould.

Four skins—one from the Northern Territory in Australia, two from " Australia ", and one without locality.

Geopelia striata tranquilla Gould.

Three skins from New South Wales, Australia.

Subfamily *Phabinae.*

Genus **Oena** Swainson.

Oena capensis capensis (Linnaeus).

(The Namaqua Dove.)

Ten skins—five from various places in Eritrea and five from Abyssinia—all collected by Mr. W. T. Blanford in 1868.

Genus **Turtur** Boddaert.

Turtur abyssinicus abyssinicus (Sharpe).

(The Abyssinian Black-bellied Blue-spotted Wood-Dove.)

Six skins from the Anseba and Lebka Valleys and Samhar, all in Eritrea. Collected by Mr. W. T. Blanford in 1868. Blanford (1870, p. 417) wrongly described them as *Peristera afra* (Linn.). In the older literature the Spotted Wood-Doves of E. Africa were confused with one another, and the differences have been clarified only in comparatively recent years. Three similar-looking and co-existing species are involved, namely, *Turtur abyssinicus* (Sharpe), *T. after* (Linnaeus) and *T. chalcospilos* (Wagler). The clarification of the differences is due to Erlanger (1901, p. 183), Sclater & Mackworth-Praed (1920, pp. 834-836) and Friedmann (1930, p. 239).

The Indian Museum specimens agree with the plumage characters of *T. abyssinicus* given by Sclater & Mackworth-Praed, the bill too, in dried skins, being horny-brown with black tips. Furthermore, Blanford (1870, p. 417), who collected these skins, gave the colour of the fresh bill as " deep purple ", whereas in *afer* it is yellow or orange. The back is brown instead of grey, but this, I think must be due to fading.

Genus **Chalcophaps** Gould.

Chalcophaps indica chrysochlora (Wagler)

Three skins from New South Wales, Australia.

Genus **Phaps** Selby.

Phaps chalcoptera chalcoptera (Latham).

(The Bronze-winged Pigeon.)

One ♀ from New South Wales, Australia.

Phaps chalcoptera (Latham) (subsp. ?).

Three skins from Australia.

Phaps elegans neglecta Mathews.

Three skins—two from New South Wales, and one juvenile from "Australia".

Genus **Ocyphaps** G. R. Gray.

Ocyphaps lophotes (Temminck).

Three skins—one from New South Wales in Australia, one from an unknown locality, and one juvenile bred in the Zoological Gardens, Calcutta.

Genus **Geophaps** G. R. Gray.

Geophaps scripta (Temmnick) (subsp. ?).

Two skins, unknown locality.

Subfamily *GEOTRYGONINAE*.

Genus **Leucosarcia** Gould.

Leucosarcia melanoleuca (Latham).

(The Larger Wonga-Wonga.)

Two skins from New South Wales, Australia.

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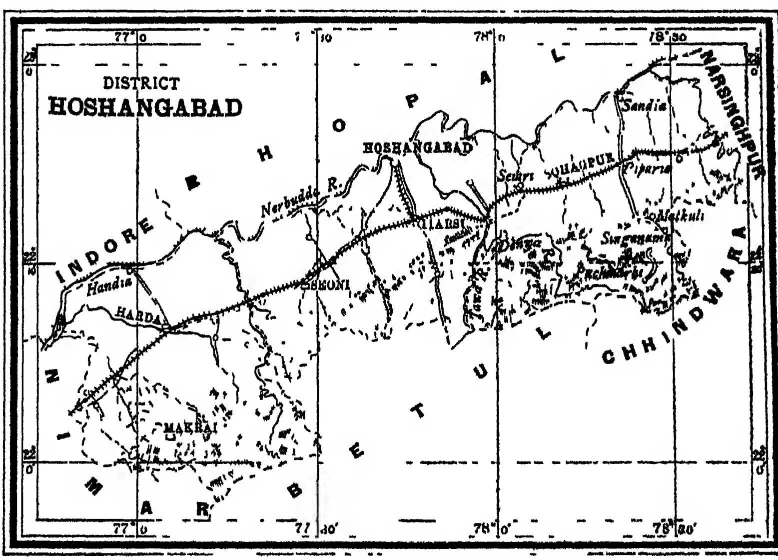
V. Index.

FISHES OF THE SATPURA RANGE, HOSHANGABAD DISTRICT, CENTRAL PROVINCES.

By Sunder Lal Hora, *D.Sc.*, *F.R.S.E.*, *F.N.I.*, *Assistant Superintendent and* K. Krishnan Nair, *M.Sc.*, *Gallery Assistant, Zoological Survey of India, Calcutta.*

In 1937, one of us[1], while referring to the distribution of Himalayan fishes, explained the occurrence of similar forms in the Eastern Himalayas and the Assam Hills on the one hand and the south-western hills of Peninsular India on the other by suggesting that the Satpura Trend of mountains probably stretched across India as a continuous range from the Assam Himalayas to Gujarat from the Miocene period till comparatively recent times. To test this hypothesis, the Zoological Survey of India has made collections in the Rajmahal Hills[2], Santal Parganas[3], Hazaribagh Hills[4], headwaters of the Mahanadi River, Raipur District[5], and from the Satpura Range, Hoshangabad District.



Map of the Hoshangabad District, Central Provinces, showing the localities in which collections of fish were made.

The last locality was visited by Drs. B. N. Chopra and M. L. Roonwal, who made an extensive collection of fish in the small hill-streams arising from the Satpura Range in the vicinity of the Pachmarhi Plateau and

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1 Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 255 (1937).
2 Hora, S. L., *Rec. Ind. Mus.* XL, pp. 169-181 (1938).
3 Mr. K. N. Das is preparing a report on the fish collected by Dr. H. A. Hafiz in the Santal Parganas during November-December, 1938.
4 Das, K. N., *Rec. Ind. Mus.* XLI, pp. 437-450 (1939).
5 Hora, S. L., *Rec. Ind. Mus.* XLII, pp. 365-374 (1940).

from comparatively sluggish streams in the plains at Itarsi and Harda. Dr. Chopra has very kindly supplied us the following note on the physical features and the ecological conditions of the area surveyed :

"The Hoshangabad District[1] in the Central Provinces of India lies between latitude 21° 53′ and 22° 59′ N. and longitude 76° 47′ and 78° 44′ E. It is a long and narrow strip of country stretching along the left bank of the Nerbudda, between the Vindhyan mountains and the Satpura hills, and includes parts of the latter range within its borders. The Nerbudda forms the northern boundary of the District.

"The drainage of the Hoshangabad District need not be considered in detail but for the purpose of this note it may be stated that many streams, large and small, flow down from the Satpuras, generally in a north-westerly direction, into the Nerbudda. The Nerbudda itself is a large river flowing between somewhat steep banks along the northern boundary of the District. From the eastern slopes of the Pachmarhi hills in the south-east corner of the District the water is collected in a large number of streams and flows into the Denwa which, after a short northerly course, turns due west near Matkuli, about 14 miles below Pachmarhi, and joins the Tawa which is the most important tributary of the Nerbudda in this District. The western slopes of the Pachmarhi hills are drained by the Sonbhadra, which flows north to join the Denwa. Another important tributary of the Denwa is the Nag Dewali, which rises near Pachmarhi in the deep gorge known as Jambudwip and descends north-westwards through the hills to join the Denwa. This stream forms a series of charming cascades. The Nerbudda has several other important tributaries also, but the only one that need be mentioned here is the Ajnal which passes close to Harda and joins the Nerbudda in the north-west corner of the District. Near Itarsi, practically in the centre of the District, a small stream flows in a north-westerly direction and joins the Lathia, before it falls into the Nerbudda.

"The plateau of Pachmarhi lies at an elevation of about 3,500 feet, with the Mahadeo hills of the Satpura range forming a rugged background of great beauty and rising in places to almost 4,500 feet above the sea-level. The plateau is formed of almost level or slightly undulating stretches of grassy glades, interspersed with clumps of forest trees. The prevailing sandstone, which is of great depth and succumbs readily to denudation, has, under the action of water, formed a maze of gorges and ravines in which numerous streams flow. The plateau receives a rainfall of about 77 inches a year and nearly the whole of it falls between June and September. The climate is rather mild, the average minimum and maximum temperatures ranging between 17·5° and 95·1° F.

"The plains consist of a rich alluvium, the average rainfall is about 47 inches per annum and the average minimum and maximum temperatures at Hoshangabad vary between 71·3° and 107·6° F.

"The survey was carried out in February and March, which are practically the driest months in the year in the District. The streams in the hills, that is, around the Pachmarhi plateau, had only a restricted flow, while those in the plains had naturally considerable quantities of water in them. In a few of the former the current was merely in the form of a trickle and in none was the flow very rapid, except near cascades and falls. There were pools in the course of most of these streams and rich collections were obtained in these pools. The bottom for the most part consisted of stones and pebbles mixed with sand and clay, but in the pools and in some other parts also there was a lot of mud. This was especially the case in some parts of the small streams round Badkachar. In some cases the water flowed over large rocks and boulders, some of which had been worn flat by the current; this was the case in the vicinity of the Small Water Fall, some parts of the stream in the Jambudwip gorge and that in the neighbourhood of the Pansy Pool. There was only a small amount of vegetation in most of the streams, except in some near Badkachar and those near Singanama. In many cases the country through which the streams were flowing was thickly wooded; this was especially the case with the streams near Pansy Pool, that near Rohrighat and the Jambudwip. The streams round Badkachar, that near Darmar and one or two others flowed through country which was for the most part bare. The water in all these streams was clear. In the hill-streams the dominant fish at this time of the year was *Garra mullya*. This fish was collected in practically every stream, sometimes in considerable numbers, and was found even in pools with a muddy bottom and slow current. Two species of *Nemachilus*, locally known as *Patharchat* (stone licker) were also met with practically everywhere, living under stones and hiding in the vegetation near banks. Another fish collected in some streams in considerable numbers is *Danio aequipinnatus*. This prominently striped fish was found to be the dominant form in streams round Badka-

[1] The information regarding physical features, etc., has been taken partly from the Hoshangabad District Gazetteer by Corbett and Russel (1908), and that about the distribution of fishes from the lists prepared by Dr. Hora and Mr. Nair.

char, at Rohrighat and in some streams round Singanama; in these streams *Garra* was collected in comparatively smaller numbers. Several other species also were collected in these streams, the genera represented being *Parapsilorhynchus*, *Barbus*, *Barilius*, *Rasbora*, *Lepidocephalus*, and *Ophiocephalus*.

"The streams in the plains differed considerably in their physical conditions from those described above. In most of these there was a considerable flow of water, the current was sluggish to moderately swift and the bottom for the most part consisted of sand and mud, with occasional patches of small stones and pebbles. There was considerably more vegetation in the water than in the hill-streams and in the Ajnal nullah near Harda there was such a luxurious growth of algae and other vegetation in the stream that it required considerable efforts to wade through it. This thick vegetation afforded excellent protection to large numbers of fish and though plenty of them could be seen darting about from cover to cover, it was difficult to bag them. The course of these streams lay through country that was for the most part only sparsely wooded, and in parts was quite bare. The water was more or less clear. *Garra* was practically absent in these streams and was collected in small numbers only in the stream near Mehragaon, close to Itarsi. *Nemachilus* was collected in practically all these streams, but of the two species found in the hills, one, *N. evezardi*, was totally absent in the plains, while the other, *N. dayi*, was common throughout. A third species of *Nemachilus*, *N. botius*, which was met with rather rarely in the hills, was found in fair numbers in these streams. There are several species that were common to both the localities, but some of these were more abundant in one than in the other. Barbels were far more common, both in the number of species and in individuals, in the plains than in streams round Pachmarhi. Among the genera met with in the streams in the plains only may be mentioned *Brachydanio*, *Esomus*, *Labeo*, *Rohtee*, *Oreichthys*, *Amblyceps*, *Xenentodon*, *Badis*, *Laguvia*, *Glossogobius*. In all 26 genera were collected; of these, nine were found in the hill streams also."

DESCRIPTIONS OF LOCALITIES WITH LISTS OF FISHES COLLECTED FROM EACH.

Jambudwip stream, about 2 miles north-west of Pachmarhi. 9. ii. 1941.

This is a typical hill-stream running in a deep well-wooded valley. The bottom is rocky or strewn over with stone and pebbles in some places and muddy in others. The current is not very fast, except in the regions of small falls and cascades. Portions of the stream contain plenty of vegetation. Here and there large pools are formed with the bottom generally muddy. In some places the stream flows as a small trickle over a bed of large flat rocks.

	Length in mm.	No. of specimens.
Garra mullya (Sykes)	59—69	4
Parapsilorhynchus tentaculatus (Ann.)	26—41	5
Nemachilus dayi Hora	26—40	12
Nemachilus evezardi Day	18—52	11

"*Pansy Pool*", *about 4 miles south-west of Pachmarhi.* 10. ii. 1941.

The Denwa river runs in places through a deep *khud* between high rocks and forms a series of deep pools, popularly known as "Pansy Pool". The current is generally sluggish but in between the pools rapids are formed. The bottom consists of rocks and stones intermixed with pebbles and sand. Parts of the stream are thickly shaded, but there is little vegetation in the water.

	Length in mm.	No. of specimens.
Barbus (*Tor*) *khudree* Sykes	33	1
Garra mullya (Sykes)	39—76	20
Nemachilus dayi Hora	21—57	8
Nemachilus evezardi Day	23—28	3

"Small Waterfall" about 2 miles east of Pachmarhi. 11. ii. 1941.

The waterfall is about 75 feet high and below it there is a typical hill-stream formed of rapids and pools in succession. The bottom is formed of pebbles and brownish sand, and the banks are overgrown with grasses and forest trees. Some of the pools are over 10 feet deep and the current in them is sluggish.

	Length in mm.	No. of specimens.
Barilius bendelisis Ham.	16 – 85	13
Danio aequipinnatus (McClell.)	55– 73	7
Barbus (*Puntius*) *dorsalis* (Jerdon)	53 & 56	2
Barbus (*Puntius*) *ticto* Ham.	28—53	5
Parapsilorhynchus tentaculatus (Ann.)	31	1
Nemachilus evezardi Day	26--35	4

Darmar stream near Darmar village, below Pachmarhi-Piparia Road about 3 miles north-east of Pachmarhi. 12. ii. 1941.

A small stream with a comparatively slow current of clear water flowing over stones and boulders, and in places over sand and shingle, etc. In the course of the stream there are several pools with muddy bottom and a sluggish current. There is no vegetation in the water but there are some tall trees along the banks.

	Length in mm.	No. of specimens.
Garra mullya (Sykes)	29 - 78	113
Nemachilus dayi Hora	25 83	16
Nemachilus evezardi Day	20 38	7

Streams around Badkachar, about 6 miles north-west of Pachmarhi. 14. ii. 1941.

The streams are small and sluggish with restricted flow over a bottom of stones and rocks. In places the bottom is muddy. There is very little of aquatic vegetation, but there are trees along the banks of the streams.

	Length in mm.	No. of specimens.
Danio aequipinnatus (McClell.)	45 – 76	16
Parapsilorhynchus tentaculatus (Ann.)	23--28	7
Nemachilus dayi Hora	31--65	6

Rohrighat stream near Rohrighat village, about 8 miles south-west of Pachmarhi. 15. ii. 1941.

A small, comparatively sluggish stream running on two sides of the village. In places the stream runs through open country without any shade, while in other places the banks are very thickly wooded. There is very little aquatic vegetation. The bottom is mostly muddy, but

in places there are lots of stones. The stream forms several pools in its course.

			Length in mm.	No. of specimens.
Barilius bendelisis Ham. ..	..	..	105 & 110	2
Danio aequipinnatus (McClell.)	..	..	42—86	64
Rasbora daniconius (Ham.)	..	..	97	1
Garra mullya (Sykes) ..	..	..	43—75	7
Nemachilus dayi Hora ..	..	..	23—79	12
Ophiocephalus gachua Ham.	..	..	120	1

Choka nullah near Singanama on the Pachmarhi-Piparia Road, about 11 miles from Pachmarhi. 18 & 20. ii. 1941.

A small sluggish stream with a muddy bottom, which is strewn over with rocks in places. Pools in the course of the stream are almost stagnant and have a lot of algae and other aquatic vegetation. The bottom consists of black mud, mixed with sand. The water is generally clear. This stream joins the Denwa a little below Singanama village.

			Length in mm.	No. of specimens.
Barilius bendelisis Ham. ..	..	..	..	Several young specimens.
Danio aequipinnatus (McClell.)	..	..	19—72	11
Rasbora daniconius (Ham.) ..	..	...	41—78	7
Barbus (Puntius) dorsalis (Jerdon)	..	..	41	1
Barbus (Puntius) ticto Ham.	..	..	32—63	5
Barbus (Tor) khudree Sykes.	..	..	33 & 37	2
Garra mullya (Sykes) ..	..	..	57—65	5
Lepidocephalus guntea (Ham.)	..	..	60 & 66	2
Nemachilus dayi Hora ..	..	..	66	1
Ophiocephalus gachua Ham. ..	..	..	83 & 88	2

Denwa river near Singanama, on Pachmarhi-Piparia Road, about 11 miles from Pachmarhi. 19 & 20. ii. 1941.

The Denwa opens out into a broad stream of clear water flowing over a bed of sand, with large rocks here and there. The water is clear and there is very little aquatic vegetation. The current is moderately swift. On the sides of the river there are isolated pools

			Length in mm.	No. of specimens.
Barilius bendelisis Ham. ..	..	..	27—98	58
Danio aequipinnatus (McClell.)	..	..	16—70	5
Rasbora daniconius (Ham.)	..	..	58 & 75	2
Barbus (Puntius) pinnauratus (Day)	..	..	82	1
Barbus (Puntius) ticto Ham.	..	..	25—47	3
Barbus (Tor) khudree Sykes	..	..	20—68	27
Garra mullya (Sykes) ..	..	..	56—80	9
Garra gotyla (Gray) ..	..	..	63	1
Nemachilus botius (Ham.) ..	..	..	76	1

Mahabir nullah just behind the Rest House at Singanama on Pachmarhi-Piparia Road, 14 miles from Pachmarhi. 20. ii 1941.

The nullah consists of small, isolated pools with a small trickle of water flowing in between them. The bottom consists of rocks and stones with patches of sand and darkish mud. The water is clear. There is no aquatic vegetation.

	Length in mm.	No. of specimens.
Barilius bendelisis Ham.	..	Several young specimens.
Danio aequipinnatus (McClell.)	12 75	30
Rasbora daniconius (Ham.)	19 - 91	17
Barbus pinnauratus (Day)	91	1
Barbus (*Puntius*) *dorsalis* (Jerdon)	50 & 64	2
Barbus (*Puntius*) *ticto* Ham.	40 66	5
Garra mullya (Sykes)	50 & 61	2
Lepidocephalus guntea (Ham.)	65	1
Nemachilus dayi Hora	38 & 45	2

Machhuasa or Mochha stream about 1½ miles north of Piparia, and under Railway bridge close to Railway Station. 22 & 23. ii. 1941.

A small stream of clear water flowing slowly over a bed of sand and clay. The vegetation consists of algae and grasses.

		No. of specimens.
Barilius bendelisis Ham.	45 71	14
Brachydanio rerio (Ham.)	22 30	13
Rasbora daniconius (Ham.)	69	1
Barbus (*Puntius*) *ticto* Ham.	25 & 27	2
Lepidocephalus guntea (Ham.	45 71	19
Nemachilus dayi Hora	26 32	6

Stream near Mehra village, about 1½ miles from Itarsi. 24-26. ii. 1941.

It is a small sluggish stream running over a bed of gravel and mud. The banks are muddy and steep in places. The water is somewhat turbid and harbours large quantities of filamentous algae.

		No. of specimens.
Chela clupeoides (Bloch)	63 & 71	2
Laubuca laubuca (Ham.	56	1
Brachydanio rerio (Ham.)	25- 28	11
Danio aequipinnatus (McClell.)	47	1
Esomus danricus (Ham.)	37—44	25
Rasbora daniconius (Ham.)	41 —67	14
Barbus (*Puntius*) *chrysopoma* (Jerdon)	117 & 126	2
Barbus (*Puntius*) *dorsalis* (Jerdon)	41	1
Barbus (*Puntius*) *sophore* Ham.	35 48	4
Barbus (*Puntius*) *ticto* Ham.	32 - 58	49
Barbus (*Puntius*) *titius* Ham.	59—81	9
Barbus (*Tor*) *khudree* Sykes	104	1
Garra mullya (Sykes)	63—94	5
Labeo boggut (Sykes)	80—97	3
Rohtee cotio (Ham.)	50—58	7
Lepidocephalus guntea (Ham.)	52—67	10
Nemachilus dayi Hora	37—54	4
Mystus vittatus (Bloch)	65 - 88	17
Ophicephalus gachua Ham.	67 130	4
Ophicephalus punctatus Bloch	80 - 145	9
Glossogobius giuris (Ham.)	28 65	24

Nerbudda river near Handia, about 13 miles north of Harda. 27. ii. 1941.

A large river of clear water, flowing over a bed of sand and clay. There is a large number of rocks and boulders on the bank with pools in between them. Near the edge, there is a growth of grasses and algae. The bottom of the pools is muddy.

	Length in mm.	No. of specimens.
Barbus (Puntius) ticto Ham.	13—22	12
Barbus (Tor) khudree Sykes	35—43	3
Nemachilus dayi Hora	26—39	4

Timarni nullah on the Timarni Road, a little south of Harda. 28. ii. *and* 2 iii. 1941.

The nullah forms a branch of the Ajnal river, and is a fairly large stream of clear water, flowing over a bed of clay mixed with sand and gravel. In some places the bottom is stony. The vegetation consisting of grasses and algae is quite abundant in the shallower parts of the stream. The banks are fairly steep.

	Length in mm.	No. of specimens.
Barilius bendelisis Ham.	32—111	11
Brachydanio rerio (Ham.)	26—31	3
Danio aequipinnatus (McClell.) .. .	58	1
Barbus (Puntius) chrysopoma (Jerdon)	180	1
Barbus (Puntius) conchonius (Ham.)	38—61	10
Barbus (Puntius) dorsalis (Jerdon)	76	1
Barbus (Puntius) gugañio (Ham.)	33—44	11
Barbus (Puntius) pinnauratus (Day)	71—89	9
Barbus (Puntius) ticto Ham.	28—65	8
Barbus (Puntius) titius Ham.	84	1
Barbus (Tor) khudree Sykes	89—97	4
Garra mullya (Sykes)	15—90	7
Labeo boggut (Sykes)	57—95	12
Oreichthys cosuatis (Ham.)	28—41	5
Rohtee cotio (Ham.)	57—71	5
Lepidocephalus guntea (Ham.)	37	1
Nemachilus dayi Hora	25—60	26
Nemachilus botius (Ham.)	47	1
Mystus vittatus (Bloch)	85—90	3
Amblyceps mangois (Ham.)	23—44	6
Xenentodon cancila (Ham.)	76 & 108	2
Mastacembelus armatus (Lacép.)	95—148	4
Mastacembelus pancalus (Ham.)	70—85	3
Ophicephalus gachua Ham.	132	1
Badis badis (Ham.)	31	1
Glossogobius giuris (Ham.)	38—107	3

Ajnal nullah near the Railway bridge about 2 miles south-west of Harda. 1. iii. 1941.

A fairly large stream of clear water, running between steep banks over a bottom consisting mostly of small pebbles, etc., mixed with

sand and mud. The current is fairly swift. Large masses of algae were found growing in the water.

	Length in mm.	No. of specimens.
Notopterus notopterus (Pallas)	200	1
Barilius bendelisis Ham.	..	Several young specimens.
Danio aequipinnatus (McClell.)	83	1
Barbus (Puntius) dorsalis (Jerdon)	71	1
Barbus (Puntius) pinnauratus (Day)	86	1
Barbus (Puntius) ticto Ham.	26-55	11
Barbus (Tor) khudree Sykes	71--142	8
Garra mullya (Sykes)	70—88	7
Labeo boggut (Sykes)	105	1
Lepidocephalus guntea (Ham.)	41 57	3
Nemachilus dayi Hora	27—60	14
Nemachilus botius (Ham.)	56—71	4
Xenentodon cancila (Ham.)	51	1
Mastacembelus armatus (Lacép.)	70—109	4
Ophicephalus punctatus Day	190	1
Glossogobius giuris (Ham.)	98	1

Midkul nullah near the Railway bridge, about 2 miles south-west of Harda. 3. iii. 1941.

The stream is about 40-60 feet wide and 2-5 feet deep. The current is sluggish and the vegetation consists of reeds, etc. The bottom consists of coarse sand and large stones here and there.

	Length in mm.	No. of specimens.
Rasbora daniconius (Ham.)	40	1
Barbus (Puntius) gugunio (Ham.)	34—48	7
Barbus (Puntius) pinnauratus (Day)	80	1
Barbus (Puntius) ticto Ham.	22--51	7
Barbus (Tor) khudree Sykes	85	1
Oreichthys cosuatus (Ham.)	30—45	11
Nemachilus botius (Ham.)	53—66	6
Mystus vittatus (Bloch)	84	1
Laguvia rebeiroi Hora	21 & 28	2
Mastacembelus armatus (Lacép.)	88	1
Nandus nandus (Ham.)	108	1
Badis badis (Ham.)	18—46	6
Glossogobius giuris (Ham.)	37	1

Fishes purchased from markets at Sandia and Harda.

Purchased in the market at Sandia, on River Nerbudda, 12 miles from Piparia on 21. ii. 1941.

	Length in mm.	No. of specimens.
Mystus cavasius (Ham.)	108	1
Mystus vittatus (Bloch)	75—80	3

Purchased in the market at Harda on 28. ii. 1941.

	Length in mm.	No. of specimens.
Rita pavimentata Val.	152—160	3
Mastacembelus armatus (Lacép.)	277	1

SYSTEMATIC ACCOUNT.

The collection under report comprises 1,167 specimens belonging to 40 species. The systematic position of the species is shown in the following table :

Family NOTOPTERIDAE.

1. *Notopterus notopterus* (Pallas).

Family CYPRINIDAE.

Subfamily *ABRAMIDINAE.*

2. *Chela clupeoides* (Ham.).
3. *Laubuca laubuca* (Ham.).

Subfamily *RASBORINAE.*

4. *Barilius bendelisis* Ham.
5. *Brachydanio rerio* (Ham.).
6. *Danio aequipinnatus* (McClell.).
7. *Esomus danricus* (Ham.).
8. *Rasbora daniconius* (Ham.).

Subfamily *CYPRININAE.*

9. *Barbus (Puntius) chrysopoma* Cuv. & Val.
10. *Barbus (Puntius) conchonius* Ham.
11. *Barbus (Puntius) dorsalis* (Jerdon).
12. *Barbus (Puntius) guganio* (Ham.).
13. *Barbus (Puntius) pinnauratus* (Day).
14. *Barbus (Puntius) sophore* Ham.
15. *Barbus (Puntius) ticto* Ham.
16. *Barbus (Puntius) titius* Ham.
17. *Barbus (Tor) khudree* Sykes.
18. *Garra mullya* (Sykes).
19. *Garra gotyla* (Gray).
20. *Parapsilorhynchus tentaculatus* (Ann.).
21. *Labeo boggut* (Sykes).
22. *Oreichthys cosuatus* (Ham.).
23. *Rohtee cotio* (Ham.).

Family COBITIDAE.

24. *Lepidocephalus guntea* (Ham.).
25. *Nemachilus botius* (Ham.).
26. *Nemachilus dayi* Hora.
27. *Nemachilus evezardi* Day.

Family BAGRIDAE.

28. *Mystus cavasius* (Ham.).
29. *Mystus vittatus* (Bloch).
30. *Rita pavimentata* Val.

Family AMBLYCEPIDAE.

31. *Amblyceps mangois* (Ham.).

Family SISORIDAE.

32. *Laguvia ribeiroi* Hora.

Family BELONIDAE.

33. *Xenentodon cancila* (Ham.).

Family MASTACEMBELIDAE.

34. *Mastacembelus armatus* (Lacép.).
35. *Mastacembelus pancalus* (Ham.).

Family OPHICEPHALIDAE.

36. *Ophicephalus gachua* Ham.
37. *Ophicephalus punctatus* Bloch.

Family NANDIDAE.

38. *Nandus nandus* (Ham.).

Family PRISTOLEPIDAE.

39. *Badis badis* (Ham.).

Family GOBIIDAE.

40. *Glossogobius giuris* (Ham.).

Of the 40 species listed above, 26 belong to the order Cyprinoidea (22 Cyprinidae and 4 Cobitidae), 5 to the order Siluroidea (3 Bagridae, 1 Amblycepidae and 1 Sisoridae), while the remaining species are distributed among the families Notopteridae (1), Belonidae (1), Mastacembelidae (2), Ophicephalidae (2), Nandidae (1), Pristolepidae (1) and Gobiidae (1). With the exception of a few species of carp-minnows, all others are fairly well known and do not call for any comments from a systematic point of view. However, a few remarks are necessary on *Danio aequipinnatus* (McClelland), *Barbus* (*Puntius*) *chrysopoma* Cuv. & Val., *Nemachilus dayi* Hora, *Amblyceps mangois* (Ham.) and *Laguvia ribeiroi* Hora.

From a zoogeographical point of view the occurrence of *Amblyceps* and *Laguvia* in the Hoshangabad District shows the affinities of the fish-fauna of this region with that of the Assam Hills and the Eastern Himalayas. The former genus has been obtained from all the portions of the Satpura Trend surveyed by the Zoological Survey of India, while *Laguvia* was collected only in the Rajmahal Hills. The presence in

the collection of forms, such as *Barbus* (*Puntius*) *dorsalis* (Jerdon), *Garra mullya* (Sykes), *Parapsilorhynchus tentaculatus* (Ann.), *Labeo boggut* (Sykes), *Nemachilus dayi* Hora, *N. evezardi* Day and *Rita pavimentata* Val., shows that the fish-fauna of this part of the Satpuras is closely allied to the fauna of the Western Ghats. Some of these species, such as *Parapsilorhynchus tentaculatus*, *Nemachilus evezardi* and *Rita pavimentata*, were not found in the Sihawa range, Raipur District.[1] The remaining species are widely distributed in India and are, therefore, of little significance in a zoogeographical discussion. These studies have clearly shown that the Satpura Trend of mountains must have, at not a very remote period, acted as a highway for the dispersal of the Eastern Himalayan and Assam forms to the Western Ghats and that the Garo-Rajmahal Gap is only a comparatively recent feature in the physiography of India. Further, it is also clear that there must have been a continuity of waterways between the Western Ghats and the Satpuras of the Hoshangabad District not very long ago as can be inferred from a large number of identical species of limited range that are found in both the regions

Though in his studies on 'The Distribution of Vertebrate Animals in India, Ceylon and Burma', Blanford[2] attached little importance to the distribution of freshwater fishes, it is significant that he had also come to similar conclusions as stated above from the distribution of other types of vertebrates. In describing the peculiarities of the fauna of the Indian Peninsula, he stated :

"The majority of the genera named are typically forest forms; the species of the Bihar-Orissa area are, with very few exceptions, the same as those of Malabar, and may have inhabited the whole of Southern India before the forests of the Deccan and Carnatic were cleared. One circumstance seems strongly to support this view. There are two kinds of *Anthracoceros* in India, one of which inhabits Ceylon and the Western or Malabar coast as far north as Ratnagiri, whilst the other inhabits the lower Himalayas and countries to the eastward. Neither is known to be found in the Deccan or Carnatic. The two meet in the Bihar-Orissa area, the Malabar form to the south, the Himalayan to the north. It is scarcely probable that the southern species would exist in the area unless it once ranged over the country intervening between Chutia Nagpur and Malabar. In the same manner the southern grackle (*Eulabes religiosa*) meets the Himalayan and Burmese grackle (*E. intermedia*) in the same area, but is not known to be met with in the Deccan or Carnatic tracts.

"That the differences between the Bihar-Orissa province and the adjoining provinces of the Indian Peninsula are not ancient is, I think, shown by the absence of distinctive genera amongst the reptiles and batrachia"

With regard to the value of freshwater fishes in zoogeographical studies, Blanford (*loc. cit.*, p. 343) stated :

"The evidence afforded by freshwater fishes varies so much with the presence or absence of suitable habitats, such as lakes and rivers, that it is generally, I think, only applicable to large areas."

The distribution of hill-stream fishes, such as *Amblyceps*, *Laguvia*, *Garra*, *Parapsilorhynchus*, *Nemachilus*, etc., can only take place along hill ranges, so there is hardly any necessity to contemplate vast level tracts of the country to be once covered with forests in order to explain the distribution of any genus occurring in the Peninsula of India on the one hand and the hills of Assam and the Eastern Himalayas on the other. Such a continuity of hill-ranges was provided by the once

[1] Hora, S. L., *Rec. Ind. Mus.* XLII, pp. 365-374 (1940).
[2] Blanford W. T., *Phil. Trans. Roy. Soc. London* (B) CXCIV, p. 392 (1901).

extensive Satpura Trend[1] which stretched from the Assam Himalayas in the east to the Western Ghats in the west We believe that the Satpura Trend not only provided a highway for the dispersal of the so-called Malayan fishes to Peninsular India, but also served as a route for the forest-loving forms among other groups of vertebrates that show a similar discontinuous range of distribution.

Danio aequipinnatus (McClelland).

1878. *Danio aequipinnatus*, Day, *Fish. India*, p. 596, pl. cl., fig. 6.

In 1934, Hora and Mukerji[2] gave an artificial key to the species of *Danio* and distinguished three closely allied species by the following characters:

I. A well-defined black mark near upper angle of gill-opening.
   A. Lateral bands breaking up anteriorly to form a mottled pattern. L. l. 37; L. tr. 10 (7½/2½) .. *D. strigillifer* Myers.
   B. Lateral bands not breaking up anteriorly to form a mottled pattern. Several well marked and uniform lateral bands. L. l. 34-36, L. tr. 10 or 11 (7½/2½ or 8½/2½) .. .. *D. aequipinnatus*[3] (McClelland).

II. Black mark near upper angle of gill-opening absent. L. l. 32-34; L. tr. 11 (8½/2½) .. .. *D. malabaricus* (Jerdon).

In 1937, Hora[4] recorded *D. strigillifer* Myers[5] from Southern India and commented on the discontinuous range of distribution of the species. In the material under report we have all gradations of colour and scale counts and find that the three species mentioned above cannot be distinguished from one another on any reliable character and should, therefore, be regarded as identical. Recently Hora and Law[6] found that the specimens of *Danio* from Travancore were *D. aequipinnatus* and that *D. malabaricus* must be regarded as a synonym of this species. The South Indian specimens of *D. aequipinnatus* grow to a larger size than those found in Northern India.

Barbus (Puntius) chrysopoma Cuvier and Valenciennes.

1878. *Barbus chrysopoma*, Day, *Fish. India*, p. 561.

Under the description of *Barbus pinnauratus*, Day (*loc. cit.*, p. 562) stated that "This form [*B. pinnauratus*] and *B. chrysopoma* may be merely varieties of a single species, while *B. sarana* is closely allied". According to Day's descriptions of *B. chrysopoma* and *B. pinnauratus*, the two species can be distinguished by the number of predorsal scales —12 in the former and 10 in the latter. Sundara Raj[7], however, found

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[1] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 255 (1937); *Proc. Nat. Inst. Sci. India* IV, p. 405 (1938).

[2] Hora, S. L. and Mukerji, D.D., *Rec. Ind. Mus.* XXXVI, p. 134 (1934).

[3] Mukerji (*Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 76, 1934) has given reasons to show that Regan's *Danio browni* (*Rec. Ind. Mus.* I, p. 395, 1907) cannot be regarded as a species distinct from *D. aequipinnatus* (McClell.).

[4] Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 10 (1937).

[5] Myers, G. S., *Amer. Mus. Novitates*, No. 150, p. 1 (1924).

[6] Hora, S. L. and Law, N. C., *Rec. Ind. Mus.* XLIII, p. 243 (1941).

[7] Raj, B. Sundara, *Rec. Ind. Mus.* XII, p. 254 (1916).

that besides other characters there are 10 to 12 rows of predorsal scales in the specimens of *B. chrysopoma* from Madras and remarked :

> "The above particulars show that Madras examples combine the characters of the three species, *B. sarana*, H. B., *B. chrysopoma*, C. and V., *B. pinnauratus*, Day, all of which according to the *Fauna of British India* may occur in Madras."

In the limited series of specimens that we have examined, it has been possible to distinguish *B. pinnauratus* from *B. chrysopoma* by the number of predorsal scales, but there seems no doubt that the three species mentioned above along with *B. caudimarginatus* Blyth and *B. sewelli* Prashad & Mukerji form a series of very closely allied species, the specific limits of which are by no means well defined.

Nemachilus dayi Hora.

1935. *Nemachilus dayi*, Hora, *Rec. Ind. Mus.* XXXVII, p. 57.
1938. *Nemachilus dayi*, Hora, *Rec. Ind. Mus.* XL, p. 240.
1938. *Nemachilus dayi*, Das, *Rec. Ind. Mus.* XL, p. 447.

Nemachilus dayi is represented in the collection by a large number of young, half-grown and adult specimens. The colouration is very variable. In young specimens the lighter bands are almost as wide as the darker ones and the dorsal and caudal fins are provided with only a few rows of spots. The characteristic colouration of the species is assumed in specimens about an inch and a half in length. From the large series of specimens now examined, it seems that the examples referred by Das (*loc. cit.*, p. 446) and Hora[1] to *N. denisonii* are referable to this species.

Amblyceps mangois (Hamilton).

1933. *Amblyceps mangois*, Hora, *Rec. Ind. Mus.* XXXV, pp. 607-621, text-figs. 1-7.
1940. *Amblyceps mangois*, Hora, *Rec. Ind. Mus.* XLII, p. 374.

The occurrence of *Amblyceps mangois* in the streams of the Hoshangabad District is of special significance. During the survey of the Satpura Trend, it has been collected from all the hilly districts and its range has thus been extended considerably westwards.

The specimens under report are juvenile. The caudal fin is deeply forked and in some the lobes, especially the upper, are greatly drawn out and pointed. The adipose dorsal is relatively short and low.

Amblyceps mangois is found along the Himalayas, hills of Assam, Burma, Siam, the Malay Peninsula and the Satpura Trend of mountains.

Laguvia ribeiroi Hora.

1921. *Laguvia ribeiroi*, Hora, *Rec. Ind. Mus.* XXII, p. 741, pl. xxix, fig. 3.
1938. *Laguvia ribeiroi*, Hora, *Rec. Ind. Mus.* XL, p. 179, text-fig. 5.

Laguvia ribeiroi was originally described from a single specimen collected from the Khoila River, a tributary of the Tista River in the Jalpaiguri District. Two more specimens of this remarkable catfish were recorded from the Morel River in the Santal Parganas. The occurrence of the species in the Hoshangabad District is of great zoo-

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[1] Hora, S. L., *Rec. Ind. Mus.* XLII, p. 373 (1940).

geographical interest as showing the probable continuity of the Satpura Trend of mountains with the hills of Assam and the Darjeeling Himalayas at a not very distant date.

It has been pointed out by Hora (*loc. cit.*, 1938) that *L. ribeiroi* can be readily distinguished from *L. shawi* by the nature of the dorsal spine which is serrated anteriorly in *L. ribeiroi* and is smooth in *L. shawi*. In the chest region, there are folds of skin which form an adhesive apparatus similar to that found in species of *Glyptothorax* Blyth. Recently, Hora and Gupta[1] described similar corrugations in *L. shawi*.

SUMMARY.

The collection comprises 40 already known species. A note on the physical features and ecological conditions of the area from which the collection was made is added. Short descriptions of localities with lists of fishes collected from each are also included. A reference is made to the zoogeographical distribution of *Amblyceps* and *Laguvia*, the Eastern Himalayan forms, and of *Parapsilorhynchus*, *Nemachilus evezardi*, *Rita pavimentata*, etc., of the Western Ghats. The significance of the Satpura Trend in the distribution of Malayan forms to Peninsular India is discussed. Notes are appended on *Danio aequipinnatus* (McClelland), *Barbus (Puntius) chrysopoma* Cuv. & Val., *Nemachilus dayi* Hora, *Amblyceps mangois* (Ham.) and *Laguvia ribeiroi* Hora.

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[1] Hora, S. L. and Gupta, J. C., *Journ. Roy. As. Soc. Bengal* (3) VI, p. 5, 1940 (1941).

TWO NEW CYPRINID FISHES FROM TRAVANCORE, SOUTH INDIA, WITH REMARKS ON *BARBUS* (*PUNTIUS*) *MICROPOGON* CUV. AND VAL.

By B. Sundara Raj, *Diwan Bahadur, M.A., Ph.D.* (*Liverpool*).

In a recent article,[1] a remarkable new genus of the Schizothoracine fishes was described from the Periyar Lake, Travancore, and attention was directed to the location and physical features of the Lake. Of the two new Cyprinid fishes, which form the subject matter of the present article, one was obtained from the Lake, while the other was collected from the Kallar, a tributary of the Pambiyar River, a few miles to the south of the Lake.

In their account of the freshwater fishes of Travancore, Hora and Law[2] have referred to the preponderance of endemic species in Peninsular India and indicated that this fauna must have been isolated from that of the rest of India for a considerable period. The two new forms of fish described in this paper add further to their list of the endemic species known from the State.

I wish to express here my great indebtedness to Dr. Baini Prashad and Dr. S. L. Hora of the Zoological Survey of India for the loan of material, literature and suggestions. The illustrations were prepared by the artists of the Zoological Survey of India under the supervision of Dr. Hora.

Barbus (Puntius ophicephalus, sp. nov.

B. iii; D. 3/7; P. 1/13 (1/13-1/15)[3]; V. 1/8; A. 2/5 (2/5-3/5); C. 19 (17-19); L. l. 40+1 (40-42+1-2). L. tr. 7-7½/6.[4]

Tamil name.—Eechathalai kendai.

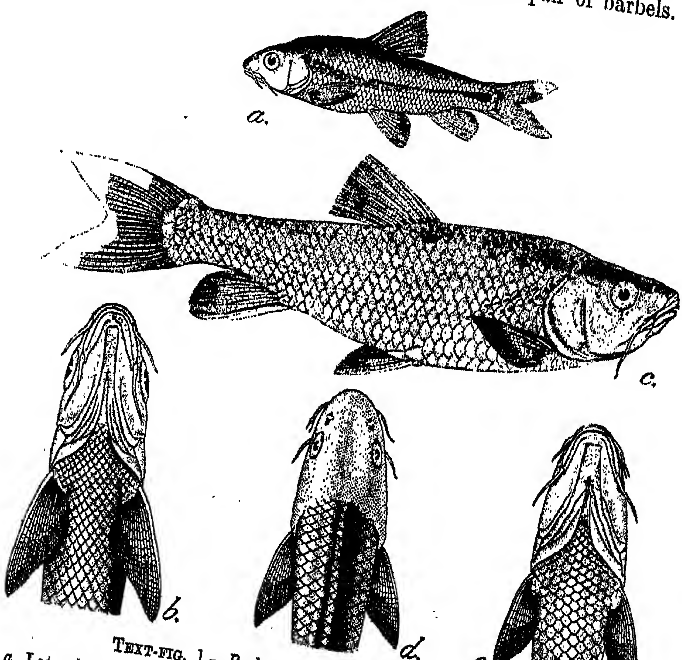
The head and anterior portion of the body are not compressed in the adult though somewhat compressed in the young. The dorsal profile is slightly more arched than the ventral; it is convex from the tip of the snout to the dorsal fin and almost straight behind that fin. The top of the head and nape are noticeably broad and flattened. The maximum depth of the body, which is at the nape or immediately behind it, is contained 4·3 (3·8-4·1) times in the standard length. The large and bluntly conical head is broad and depressed (compressed in the young). The height of the head is equal to its width (in the young the head is higher than broad) which is 2/3 of its length. The head is contained

[1] Raj, B. Sundara, *Rec. Ind. Mus.* XLIII, pp. 209–214 (1941).
[2] Hora, S. L., and Law, N. C., *Rec. Ind. Mus.* XLIII, pp. 233–256 (1941).
[3] In the descriptions which follow the scale counts and measurements of the holotype, which is the largest complete specimen collected, are given, followed within brackets by the range of variation, if any, shown by the paratypes.
[4] Counted from the origin of the dorsal fin to the lateral line and from the lateral line to the midventral row immediately in front of the root of the ventral fin, omitting the mid-dorsal, mid-ventral and lateral line rows of scales.

3·7 (3·2-4) times in the standard length. The caudal peduncle is $1\frac{1}{2}$ times as long as high at its narrowest part.

The eyes are large and rather elevated, being placed close to the dorsal profile and almost entirely in the anterior half of the head. They are distinctly dorso-lateral in position in the adult. The diameter of the eye is contained 5·5 (3·2–5·5) times in the length of the head and 2·2 (1·2–2·2) times in the interorbital space, which is more or less flat. The eyes in the young are proportionately larger.

The snout, which is somewhat prominent and broadly rounded anteriorly, is wider than long and is about 1/3 in the length of the head. It has short lateral lobes which bear the rostral pair of barbels. Its



TEXT-FIG. 1.—*Barbus (Puntius) ophicephalus*, sp. nov.
a. Lateral view of a Paratype: $\times\frac{1}{2}$; *b.* Ventral surface of head and anterior part of body of same: $\times 1\frac{1}{5}$; *c.* Lateral view of Holotype: $\times\frac{1}{2}$; *d.* Dorsal surface and anterior part of body of same: $\times\frac{1}{2}$; *e.* Ventral surface and anterior part of body of same: $\times\frac{1}{2}$.

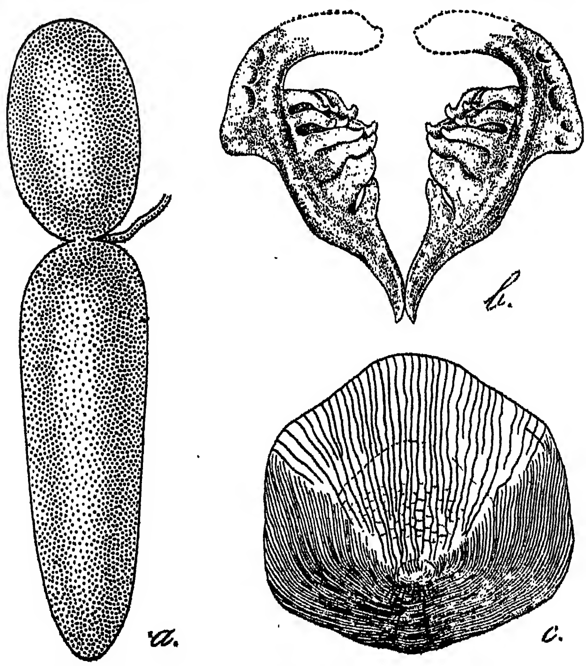
anterior margin is sharp, entire, and forms a horizontal rostral fold. A few scattered pearl organs are present on the sides of the snout in some specimens.

The mouth is subinferior and horseshoe-shaped; its cleft is more or less horizontal and does not reach below the anterior border of the eye. The upper jaw is feebly protractile and projects beyond the lower jaw. The lips, papillated in some examples, are fairly thick and continuous at the angles of the mouth by a narrow bridge and not by the whole width. The lower lip is separated from the lower jaw by a superficial furrow. The postlabial groove is narrowly interrupted in the middle.

A rostral and a maxillary pair of barbels are present; the former are equal in length to and the latter $1\frac{1}{2}$ times as long as the diameter of the eye. They are relatively shorter in the young. The left rostral barbel of the holotype is bifid, evidently an abnormality.

The gill openings are large. The gill membranes are united with the isthmus below the posterior border of the preopercle. The gill rakers are few— 4 (4-6)—widely spaced, short and stout; the longest is 2/5 of the gill filaments.

The pharyngeal teeth[1] are in three rows 5·3·2–2·3·5. They are strongly compressed and hooked, with oblique spoon-like grinding sur-



TEXT-FIG. 2.—*Barbus* (*Puntius*) *ophicephalus*, sp. nov.

a. Air-bladder : ×2 ; *b.* Pharyngeal bones and teeth : ×4 ; *c.* A scale from dorsal surface : ×6.

The above parts were dissected out from a Paratype.

faces. The pharyngeal bone is 4 times as long as broad and has a well defined anterior angle and a narrow pitted surface which does not extend beyond the angle.

The scales are moderately large, the largest being about 3/4 the size of the eye. In the scapular region the scales are broader than long and have a gently convex basal margin, more or less straight lateral margins, and a bluntly conical apex. The nuclear area is large and is basal in position. The radii are developed all round the scale. The circulii are degenerate in the apical field. A long axillary scale is present at the root of the ventral fin. The lateral line is complete, and extends in the form of open pores on the head as far as the nasal openings. There are two lateral lines on the right side of the holotype,

[1] The description is after that of Y. T. Chu, *Biol. Bull. St. John's University, Shanghai*, II, pp. 83, 84 (1935).

the upper terminating after the tenth scale, evidently an abnormality. There are 3 ($3\frac{1}{2}$–5) rows of scales between the lateral line and the base of the ventral fin, 17 (15–17) predorsal scales, and 16 rows round the caudal peduncle.

The dorsal fin, which is as long as the head from the anterior margin of the eye to the gill cleft, commences slightly nearer the tip of the snout than the base of the caudal fin, somewhat in advance of the ventral fin. It has a slightly concave or nearly straight free margin. Its last undivided ray is stiff and slightly enlarged but very weak, smooth and articulated in its upper part. The pectoral fin is somewhat falciform and as long as the head without the snout. In the young it is comparatively longer. It does not reach the ventral, when depressed, by a distance equal to half its own length. The ventral fin is shorter than the pectoral, has an obliquely truncate free margin, and does not reach the anal fin, when depressed, by a distance about two-thirds its own length (in young specimens this distance is only half the length of the fin). The anal fin, which is longer than the dorsal fin, has a rounded free margin. In the young this fin is shorter than the dorsal. It reaches when depressed, the root of the caudal fin, (in the young the anal does not reach the caudal). The caudal fin is deeply emarginate.

In fresh specimens the back and the fins are rich golden brown. the sides and the abdomen silvery brown. A broad dark band runs along the lateral line which is composed of fine black spots on the bases of the lateral line scales.

The food of the specimen dissected consisted almost exclusively of insects. The alimentary canal is about 2·75 times as long as the body.

Barbus ophicephalus is rare and was found in the Kallar, a tributary of the Pambiyar River, to the South of the Pachakani Estate adjoining the Periyar Lake. It inhabits rocky pools in which decaying vegetation is present in large quantities. The vernacular name of the fish refers to this peculiar habitat. Four specimens were collected in 1935 and seven in 1937, ranging in size from 56 to 196 mm. The measurements of the largest (holotype) and the smallest (paratype) are given below.

Holotype.—F. 13514/1, Zoological Survey of India (*Ind. Mus.*), Calcutta. Besides the holotype, 7 paratypes (F 13515/1) are also deposited in the collection of the Zoological Survey of India.

Measurements in millimetres.

	Holotype.	Paratype.
Standard length	163	42
Height of body	38	11
Length of head	44	13
Width of head	30	7
Height of head	30	9
Length of caudal peduncle	25	7
Least height of caudal peduncle	15	5
Diameter of eye	8	4
Interorbital space	18	5
Length of snout	14	4
Length of dorsal fin	33	10
Length of pectoral fin	31	9
Length of ventral fin	26	7
Length of anal fin	34	8

Remarks.—Dr. Hora called my attention to the close resemblance of this species to *Barbus lithopidos* Day.[1] It is, however, distinguished from Day's species by the absence of a horny covering to its jaws in the preserved specimens, the smaller number of its fin rays and the larger number of its lateral line and predorsal scales. I examined all the specimens of *B. lithopidos* in the collection of the Zoological Survey of India including Day's own specimens as well as one in my collection from Nilambur. The fin rays and scales in 7 specimens of *B. lithopidos*, ranging in size from 90 to 325 mm. in standard length were as follows :

D. 4/9 ; A. 3/5 ; V. 2/9 ; L. l. 36-38+1 ; Predorsal scales 11 14. In a very young specimen measuring 57 mm. in standard length the counts were :

D. 4/8 ; A. 3/5 ; V. 1/8 ; L. l. 30.

The corresponding numbers in 8 specimens of *Barbus ophicephalus*, ranging in size from 42 to 163 mm. in standard length, were as follows :

D. 3/7 ; A. 2-3/5 ; V. 2/8 ; L. l. 40 42+1 2 ; Predorsal scales 15-17 Two of the specimens of *B. lithopidos* were very young specimens measuring 57 and 90 mm. in standard length respectively. They differed from the rest in the remarkable depth of body, which was 2·6 times in the length in both, whereas in the rest the depth of body ranged from 3·3 to 3·7 times in the length. Evidently this is a characteristic of the young of *B. lithopidos*. The depth of body in *B. ophicephalus* ranges from 3·8 to 4·1 times in the length. Even in the youngest specimens, 42 mm. in standard length, the depth is 4·1 times in the length.

In *B. lithopidos*, except in the very young specimens, the anterior rays of the dorsal fin are distinctly prolonged and the caudal fin is proportionately longer with narrow, falciform, sharply pointed lobes ; whereas in *B. ophicephalus* the corresponding dorsal rays and the caudal fin are short, and the latter having broad blade-shaped lobes Finally the difference in colour is very marked. Except in the very young specimens, *B. lithopidos* has the outer rays of the caudal fin characteristically white ; this was seen in all the specimens examined, including those collected by Day nearly three-quarters of a century ago. Moreover, *B. lithopidos* is devoid of a dark lateral band on the body.

Barbus (Puntius) micropogon, subsp. **periyarensis,** nov

D. 3/9 (3-4/9) ; P. 1/15 (1/13-15) ; V. 2/8 ; A. 3/5 ; C. 19 ; L. l. 42-43+2 ; L. tr. 7/7.

Tamil name.—KARIVAN (The charcoal-coloured one).

The body is oblong and compressed, its greatest depth, which is below the commencement of the dorsal fin, is 3·2 (3·2–3·3) times in the standard length. The head is rather small, conical, and somewhat depressed. Its length is 4·5 (4·2–4·5) times in the standard length and its width is almost equal to its height. The caudal peduncle is a little longer than high ; its least height being 1·2 (1·1–1·3) times in its length.

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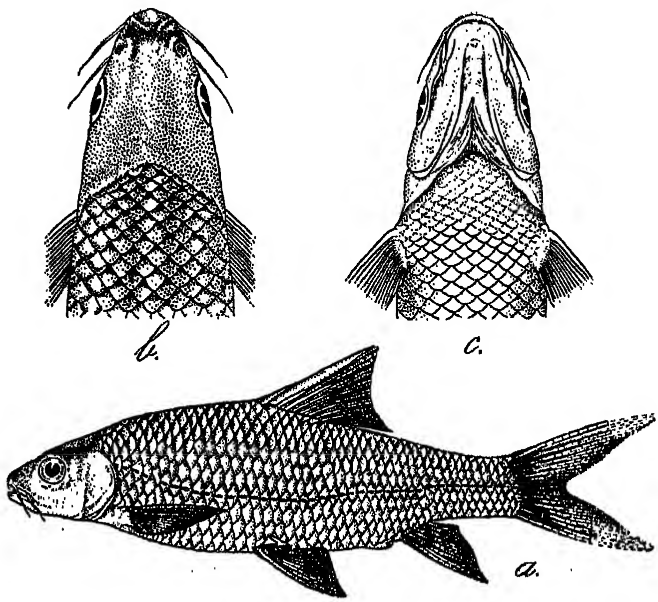
[1] Day, F., *Proc. Zool. Soc. London*, p. 708 (1873) ; *Fish. India*, p. 567, pl. cxxxviii, fig. 2 (1878) ; *Faun. Brit. Ind.* Fish. I, p. 310 (1889).

The eye is large, comparatively larger in the young; its diameter is contained 4·3 (3·1–5·5) times in the length of the head. It is placed nearer the dorsal profile than the ventral, and almost entirely in the anterior half of the head. The interorbital space is proportionately wider in the adult. It is nearly flat and is 1·7 (1·1–2·5) times in the diameter of the eye.



TEXT-FIG. 3.—*Barbus* (*Puntius*) *micropogon*, subsp. *periyarensis*, nov.

a. Lateral view of Holotype: $\times\frac{1}{3}$; *b*. Dorsal surface of head and anterior part of body of same: $\times\frac{2}{3}$; *c*. Ventral surface of head and anterior part of body of same.: $\times\frac{2}{3}$.

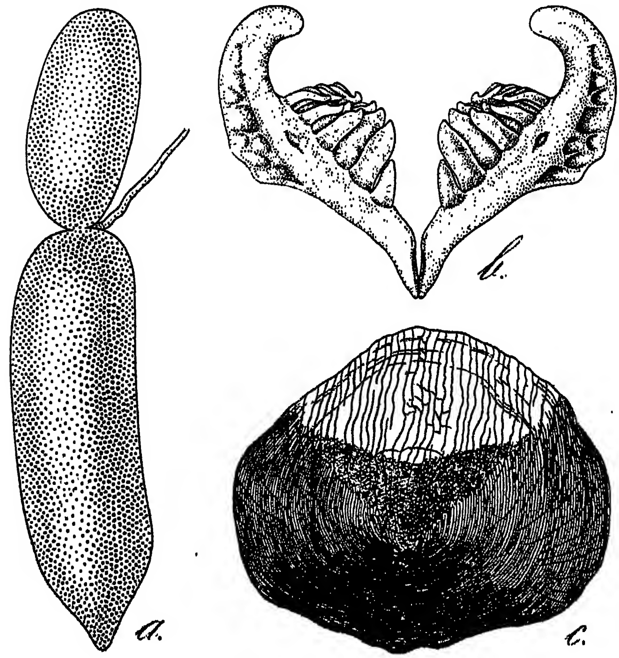
The snout is conical and bluntly pointed and has no free lateral lobes. It is 1·5 (1·1–2·2) times as long as the diameter of the eye. The mouth is semicircular and subinferior (distinctly inferior in the adult). The cleft of the mouth is nearly horizontal and does not reach below the anterior border of the eye. The rostral fold is deep, horizontal and entire. The lips are moderately developed and continuous round the corners of the mouth. The postlabial groove is interrupted in the middle. The upper jaw is longer than the lower.

A rostral and a maxillary pair of barbels of almost equal size are present, and reach well beyond the anterior and posterior borders of the orbit respectively.

The 9 or 10 gill rakers in the adult are mere stumps anteriorly; the longest of them is hardly one-fourth as long as the gill filaments. The pharyngeal bone is 2/3 as wide as long; its anterior eduntulous process is very short and the pitted surface narrow. The anterior angle is prominent.[1] The pharyngeal teeth are compressed and hooked and as usual in three rows: 5·3·2–2·3·5. The alimentary canal is a little

[1] The description is after Y. T. Chu, *Biol. Bull. St. John's University, Shanghai* II, pp. 83, 84 (1935).

over twice as long as the body and in the specimen dissected contained green vegetable matter.



TEXT-FIG. 4.—*Barbus* (*Puntius*) *micropogon* sub. sp. *periyarensis*, nov.

a. Air-bladder : $\times 1\frac{3}{4}$; *b.* Pharyngeal bones and teeth : $\times 4\frac{1}{2}$; *c.* A scale from dorsal surface : $\times 5$.

The above parts were dissected out from a Paratype.

The scales are fairly large ; the largest is of the same size as the eye. They are rounded with a wavy basal margin The nucleus is basal. The circulii are obsolescent in the apical region. The apical radii are numerous and more or less parallel ; the median ones reach the nucleus. A few lateral and basal radii are present in the scales of the caudal peduncle. There are 4 rows of scales between the lateral line and the base of the ventral fin, 16 rows round the caudal peduncle and 21 (19–21) predorsal scales.

The dorsal fin commences opposite the ventral and midway between the tip of the snout and the base of the caudal fin. It is longer than the head. The last undivided dorsal ray is osseous, smooth and much enlarged. In young specimens it is relatively longer. The free margin of the dorsal fin is concave. The first branched ray, which is the longest, when depressed, reaches $\frac{1}{2}$ ($\frac{1}{2}$–$\frac{3}{4}$) the way to the root of the caudal fin. The pectoral fins are somewhat falciform and nearly as long as the head. They reach the 12th (12th-13th) scale of the lateral line, and are separated from the base of the ventral fin by a quarter of their own length. The ventral fins have an obliquely truncate free margin and are separated from the anal fin by half their own length. The anal has an obliquely truncate free margin and when depressed reaches the base of the caudal fin (in immature specimens the anal fin is shorter). The anal fin in

breeding females is longer than the dorsal and often reaches beyond the base of the caudal. The caudal fin is deeply forked. The upper lobe is longer than the lower. The head and body are dark brown or blackish; the fins are stained black.

Measurements in millimetres.

	Holotype.	Smallest paratype.
Standard length	200	117
Length of head	47	28
Width of head	30	17
Height of head	32	18
Height of body	63	37
Length of snout	16	9
Diameter of eye	11	9
Interorbital space	19	10
Length of caudal peduncle	27	18
Least height of caudal peduncle	23	11

Holotype.—F 13516/1, Zoological Survey of India (*Ind. Mus.*), Calcutta. Besides the holotype, 1 paratype (F 13517/1) is also deposited in the collection of the Zoological Survey of India.

Remarks.—*B. micropogon*, which has not so far been recorded from Travancore, is one of the commonest fish in the lake. The above description is based on the head of a large specimen, the length of which was not noted, and three smaller specimens, which alone were preserved. For the relationships of the new subspecies reference may be made to the following account of *B. micropogon* Cuv. and Val.

REMARKS ON *BARBUS (PUNTIUS) MICROPOGON* CUV. & VAL.

Barbus (Puntius) micropogon Cuv. & Val.

1842. *Barbus micropogon.* Cuvier & Valenciennes, *Hist. Nat. Poiss.* XVI, p. 188.
1848. *Barbus mysorensis*, Jerdon, *Mad. Journ. Litt. Sci.* XV, p. 312.
1867. *Puntius (Barbodes) gracilis*, Day, *Proc. Zool. Soc. London*, p. 290.
1868. *Barbus conirostris*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 127.
1877. *Barbus conirostris*, Beaven, *Handbook. Fr. Water Fish. India*, p. 14.
1878. *Barbus micropogon*, Day, *Fish. India*, p. 563, pl. cxxxvi, fig. 3; pl. cxxxviii, fig. 4.
1889. *Barbus micropogon*, Day, *Faun. Brit. Ind.* Fish. I, p. 304.
1927. *Barbus micropogon*, Narayan Rao and Seshachar, *H. Yly. Journ. Mysore Univ.* I, pp. 117, 130.
1931. *Barbus micropogon* var. *mysorensis*, Mukerji, *Journ. Bombay Nat. Hist. Soc.* XXXV, pp. 166, 167.
1937. *Barbus micropogon*, Hora, *Rec. Ind. Mus.* XXXIX, p. 10.

There is a certain amount of confusion in the taxonomy of *Barbus micropogon.* Cuvier and Valenciennes[1] originally described this species in 1842 from Mysore; their description based on a young specimen (3" long) is meagre and is not accompanied by a figure. In 1848, Jerdon[2] described two similar species from the Cauvery, *Barbus mysorensis* with 38 scales along the lateral line in 9 rows and snout covered with mucous pores, and *Barbus gracilis* with 42 scales along the lateral line

[1] Cuvier, G. and Valenciennes, A., *Hist. Nat. Poiss.* XVI, p. 188 (1842).
[2] Jerdon, T. C., *Mad. Journ. Litt. Sci.* XV, pp. 312, 313 (1848).

in 12 rows and snout smooth. He noted that both the species occurred together in the same locality in the Cauvery and that the latter was "a very well defined species". In 1867, Day[1] in redescribing *B. gracilis* under the name *Puntius (Barbodes) gracilis* gave the number of scales along the lateral line as 40 and along the transverse series as 7/4. At the same time he described a new species *Puntius (Barbodes) dubius* from the Bhavani, a tributary of the Cauvery, with 42 scales along the lateral line, and remarked that in appearance *B. dubius* was the same as *P. gracilis* from which it might be only a sexual difference. In 1868, Günther[2] redescribed *B. micropogon* from a stuffed specimen and mentioned only $2\frac{1}{2}$ scales between the lateral line and the root of the ventral fin on account of which and other differences Day[3] did not consider Günther's *B. micropogon* as synonymous with that of Cuvier and Valenciennes. Günther[4] also described a new species, *B. conirostris*, with the scale counts "L. l. 40 and L. tr. 7/7" from specimens supplied by Day as *B. gracilis* and included *B. gracilis* Jerdon and *P. gracilis* Day in its synonymy, but recognised *B. dubius* as a valid species, with Day's reservation that as it is extremely similar to *B. conirostris* (=*P. gracilis* Day) and might be only a sexual difference. *B. mysorensis* Jerdon was considered by Günther[5] as a doubtful species. In 1870, Day[6] stated: "It appears not improbable that *B. mysorensis*, Jerdon is the same as *B. conirostris*, Günther. The species I termed *B. dubius*, I find, has five series of scales between the lateral line and the base of the ventral fin." In his later publication, Day[7] merged Jerdon's two species, *B. mysorensis* and *B. gracilis*, and Günther's *B. conirostris* in the synonymy of *B. micropogon*, but retained his own species *B. dubius* as distinct. However, he recognised *B. mysorensis* Jerdon as a variety of *B. micropogon* with numerous pores on the snout and preorbitals. In 1931, Mukerji[8] redescribed *B. mysorensis* from two specimens, 135 and 160 mm. long, in the collection of the Zoological Survey of India, and distinguished it from the *forma typica* as follows:—

B. micropogon.	*B. micropogon* var. *mysorensis.*
"1. Head less than 4 times in length of body.	Head 4·25 times in length of body.
2. Snout blunt and without tubercles	Snout pointed and covered with pointed tubercles.
3. Anal fin when laid flat extends to the base of the caudal fin.	Anal fin when laid flat extends to the middle of caudal peduncle.
4. 38-39 scales along lateral line.	41-42 scales along lateral line.
5. 12 predorsal scales.	14-15 predorsal scales."

The form from the Periyar Lake described above differs in having 42+2 scales along the lateral line and 19–21 predorsal scales, and it is on these characters that it has been kept separate as a subspecies.

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[1] Day, F., *Proc. Zool. Soc. London*, p. 290 (1867).
[2] Günther, A., *Cat. Fish. Brit. Mus.* VII, p. 126 (1868).
[3] Day, F., *Fish. India*, p. 563 (1878).
[4] Günther, A., *Cat. Fish. Brit. Mus.* VII, p. 127 (1868).
[5] Günther, A., *Cat. Fish. Brit. Mus.* VII, p. 83 (1868).
[6] Day, F., *Proc. Zool. Soc. London*, p. 373 (1870).
[7] Day, F., *Fish. India*, p. 563 (1878).
[8] Mukerji, D. D., *Journ. Bombay Nat. Hist. Soc.* XXXV, pp. 166, 167 (1931).

In order to determine the validity of the various forms of *B. micropogon* mentioned above, the following specimens in the collection of the Zoological Survey of India, the Madras Fisheries Department and the specimens collected by me from the Periyar Lake were examined.

Barbus dubius.

1. Day's type. Indian Museum No. 2373, Bhavani R. ..	250 mm. Pores on snout. L. l. 42 | 2.[1] L. tr. 9/4-5.
2. Indian Museum No. F. 12388/1, Cauvery, Coorg	64 mm. No pores on snout. L. l. 42 | 1. L. tr. 8/4.
3. Madras Fisheries Department, Cauvery, Mettur Dam. ..	320 mm. Pores on snout. L. l. 42 | 2. L. tr. 9/4½.
4. Madras Fisheries Department, Cauvery, Mettur Dam ..	230 mm. Pores on snout. L. l. 42 | 1. L. tr. 8/3½.

Barbus micropogon and varieties.

5. Indian Museum, No. 2305, Day's specimen from Bhavani R.	110 mm. No pores on snout. L. l. 39 | 1. L. tr. 7/3½.
6. Indian Museum, No. 2372, Day's specimen from Bhavani R.	200 mm. Pores on snout. L. l. 40 | 1. L. tr. 6-7/3½.
7. Indian Museum No. 2411, Day's specimen from Bhavani R.	165 mm. Pores on snout. L. l. 40 | 2. L. tr. 7/3½.
8. Indian Museum No. F. 11140/1, Burton's specimen from Bhavani R.	138 mm. Pores on snout. L. l. 39 | 1. L. tr. 7/3½.
9. Madras Fisheries Department, Cauvery, Mettur Dam. ..	120 mm. Pores on snout. L. l. 39+1. L. tr. 7/3½.
10. Madras Fisheries Department, Cauvery, Mettur Dam ..	125 mm. Pores on snout. L. l. 38 & 39. L. tr. 8/3½.
11. Madras Fisheries Department, Periyar Lake	200 mm. No pores on snout. L. l. 42+2. L. tr. 7/3½.
12. Madras Fisheries Department, Periyar Lake	150 mm. No pores on snout. L. l. 43+1. L. tr. 7/3½.
13. Madras Fisheries Department, Periyar Lake	117 mm. No pores on snout. L. l. damaged. L. tr. 7/3-3½.

[1] The additional scales are those on the caudal fin.

There is no one character which absolutely distinguishes *B. dubius* from *B. micropogon*. If, however, both the number of scales along the lateral line and the number of transverse rows of scales from the origin of the dorsal fin to the lateral line and from the lateral line to the root of the ventral fin (omitting the mid-dorsal and lateral line rows) be taken into account the specimens examined can be arranged in three groups as follows :—

GROUP 1.—L. l. 38-40+1-2 and L. tr. 7-8/3½.
Specimens Nos. 5-10 from Bhavani and Cauvery rivers named *B. micropogon* and var *mysorensis* in the collections.

GROUP 2.—L. l 42 43+1-2 and L. tr. 7/3-3½.
Specimens Nos. 11-13. The new subspecies from the Periyar Lake.

GROUP 3.—L. l. 42+1-2, and L. tr. 8-9/3½-5.
Specimens No. 1-4 from Bhavani and Cauvery rivers named *B dubius* Day in the collections.

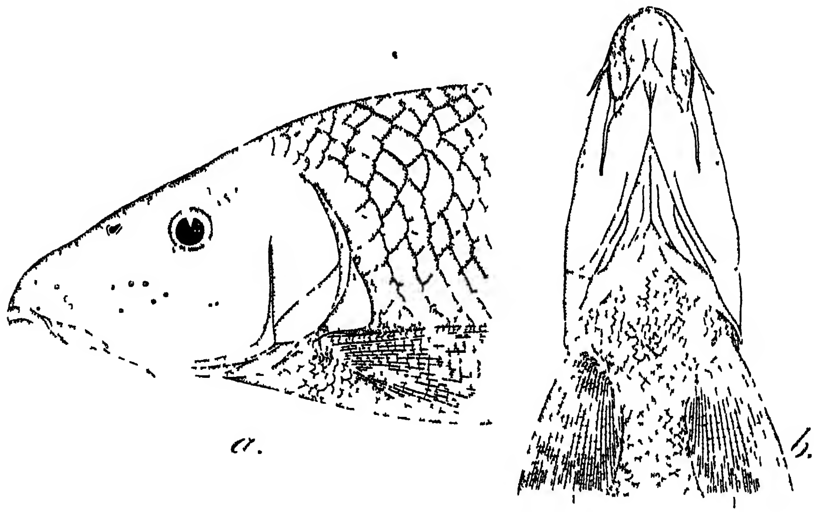
The wider range of specimens now examined in *Group* 1 does not support Mukerji's[1] attempt to distinguish *B. micropogon forma typica* from the variety *mysorensis* chiefly on the presence or absence of pores on the snout, as the other distinguishing characters mentioned by him are intermixed. For instance, specimen No. 2305, which has no pores on the snout, has a head which measures 4·2 times in standard length, while specimen No. 2372, which has pores on its snout, has an anal fin extending to the base of the caudal fin. The occurrence of pores and the prolonged anal fin will in all probability prove to be secondary sexual characters, as they are in some other species of *Barbus*.

Group 2 from the Periyar Lake is sufficiently distinct from *Group* 1 to rank as a subspecies and has accordingly been described above as new.

Group 3 represents all the specimens labelled *B. dubius* in the collections. The number of scales along the lateral line in young and adult specimens is 42 as in *Group* 2, but the latter has only 7/3½ transverse rows of scales. Further, except in one very young specimen, measuring 64 mm. (No. F. 12388/1 from Coorg), the length of the snout is twice the diameter of the eye. Though Day in all his descriptions gives the length of the snout as 1½ diameter of the eye, in his type specimen (No. 2373) as well as in his figure the length of the snout is two eye-diameters. Though in the very large specimen of *periyarensis* the diameter of the eye is contained 2·2 in the snout, the shape of the snout is very different from that of *B. dubius*. Also the eye is nearer the edge of the opercle than the tip of the snout in all the specimens of *B. dubius*, except in the very young specimen in which it is placed in the middle of the head. In *B. micropogon* and its subspecies *periyarensis*, the eye is nearer the tip of the snout and rarely in the centre of the head. The mouth of *B. dubius* is narrow and pointed anteriorly, whereas in *B. micropogon* it is broad and semicircular. Except in the very young specimens, the long and peculiarly shaped snout as well as its

[1] Mukherji, D. D., *Journ. Bombay Nat. Hist. Soc.* XXXV, pp. 166, 167 (1931).

bright pink colour changing to a uniform silvery white after preservatio readily distinguish *B. dubius* from *B micropogon* and its subspecie



TEXT-FIG. 5.—*Barbus* (*Puntius*) *dubius* Day.

a. Lateral view of head and anterior part of body: × *ca.* [illegible]; *b.* Ventral surface of head and anterior part of body: × *ca.* [illegible].

periyarensis. Further, the scales, size for size, are smaller and the dorsal spine weaker in *B. dubius.* These two characters are discernable even in very young specimens measuring two to three inches in length.

Both *B. micropogon forma typica* with 38-40 + 1 scales along the lateral line and 7-8/3½ transverse rows and *B. dubius* Day with 42 + 1-2 scales along the lateral line and 8-9/3½-5 transverse rows occur together in the Bhavani and the Cauvery. As Jerdon's *B. mysorensis* with 38 scales along the lateral line in 9 rows and *B. gracilis* with 42 scales along the lateral line in 12 rows were found by Jerdon in the same locality and the latter was considered by him " a very well defined species ", there is little doubt that the species described by Jerdon correspond to *B. micropogon* and *B. dubius* respectively. Day gave the lateral line scales in *B. gracilis* as 40, evidently mistaking it for *B. micropogon*, and redescribed the form with 42 scales as his new species *B. dubius.* Following Day, Günther also assigned the form with 40 lateral line scales to *B. gracilis* and renamed it as *B. conirostris.* Günther's *B. micropogon* is evidently not a synonym of *B. micropogon* Cuv. & Val. In his later works, Day[1] persisted in ignoring the 42 scales, the distinctive character of *B. gracilis* mentioned by Jerdon, and included both *B. mysorensis* and *B. gracilis* as synonyms of *B. micropogon.* Cuvier and Valenciennes's being the first name of the species with 38 to 41 scales along the lateral line should supersede *B. mysorensis* Jerdon and *B. conirostris* Günther. For the species with 42 scales along the lateral line *B. gracilis* Jerdon has priority over *B. dubius* Day, but as Jerdon's name is preoccupied by *B. gracilis* Schleg., the species has to be designated *B. dubius* Day.

[1] Day, F. *Fish. India*, p. 563 (1878); *Faun. Brit. Ind.* Fish. I, p. 304 (1889).

NOTES ON FISHES IN THE INDIAN MUSEUM.

XLI. New Records of Freshwater Fish from Travancore

By Sunder Lal Hora *D.Sc., F.R.S.E., F.N.I., Assistant Superintendent*, and K. Krishnan Nair, *M.Sc., Gallery Assistant, Zoological Survey of India, Calcutta*

In their recent account of 'The Freshwater Fish of Travancore', Hora and Law [1] gave a list of 76 species so far recorded from Travancore and discussed their geographical distribution. It was surmised that further research will bring to light the presence of more species of fresh water fishes from this very interesting zoogeographical area, which forms the extreme south of Peninsular India. More recently, Sundara Raj[2] has described a species of *Barbus*, *B.* (*Puntius*) *ophicephalus*, and a subspecies of the South Indian *Barbus* (*Puntius*) *micropogon* (subsp. *periyarensis* Raj) from the Kallar, a tributary of the Pambiyar River, and the Periyar Lake respectively. Mr. S. Jones, made a small collection of fish from the Kallar stream, 30 miles northeast of Trivandrum, on the 8th June 1941 and obtained specimens of the following species :—

1. *Barilius gatensis* Cuvier and Valenciennes .. .. .. 2 specimens.
2. *Danio aequipinnatus* (McClelland) . . .. 3 specimens.
3. *Barbus* (*Puntius*) *filamentosus* (Cuvier and Valenciennes) 2 specimens.
4. *Barbus* (*Tor*) *malabaricus* Jerdon .. .. .. 3 specimens.
5. *Garra jerdoni* (Day) . . .. 2 specimens.
6. *Garra mullya* (Sykes) .. . . 2 specimens
7. *Sicyopterus griseus* (Day) .. .. 5 specimens.

The last species is recorded here from Travancore for the first time ; it was described by Day[3] in 1878 from South Canara where he "had procured two examples in fresh water, the largest being 3 inches". One of Day's specimens is probably in the s'Rijks Museum van Natuurlijke Historie, Leiden, for Koumans[4] mentions to have examined an example from Canara. The whereabouts of the second specimen are not known. *Sicyopterus griseus* marks the western limits of the genus. We avail ourselves of this opportunity to redescribe this rare species from fresh material.

Mr. K. Bhaskaran Nair sent 5 specimens of a small freshwater Globe-fish, which he had collected in April from the Pamba River in Central Travancore. He noted that "It is called 'Attunta' (ball of the river) in Malayalam and children play with it by blowing into its mouth and inflating it. The general yellow colour of the body has faded now, but when fresh it gives the fish a beautiful appearance."

These specimens belong to the monotypic subgenus *Monotretus* Bibron[5] ; the only other species included in it being *Tetraodon*

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[1] Hora, S. L. and Law, N. C., *Rec. Ind. Mus.* XLIII, pp. 233-256 (1941).

[2] Raj, B. Sundara, *Rec. Ind. Mus.* XLIII, pp. 375-386 (1941).

[3] Day, F., *Journ. Linn. Soc. London* (Zoology) XIII, p. 140 (1878).

[4] Koumans, F. P., *Mem. Ind. Mus.* XIII, p. 296 (1941).

[5] Jordan, in his *Genera of Fishes* (pp. 198, 263, 1919) notes that *Monotretus* Bibron (*Rev. Mag. Zool. Paris* VII, p. 281, 1855) is a synonym of *Leiodon* Swainson (*Nat. Hist. Classification Fish*, etc. II, p. 194, 1839). A reference to Swainson's work shows that *Leiodon* is insufficiently characterized. We have, therefore, retained the name *Monotretus* for this group of 'Puffers'.

(*Monotretus*) *cutcutia* (Hamilton), which, according to Day,[1] is known from "Fresh waters of Orissa, Bengal and Assam"; it is also common in Burma[2]. This new species is also described below. The discontinuous distribution of *Monotretus* is of zoogeographical significance.

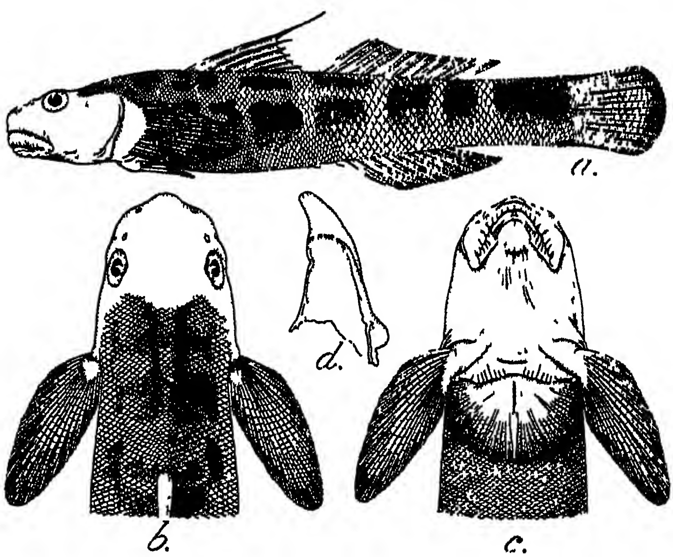
It is worthy of remark that with the exception of *Sicyopterus griseus*, which is known from South Canara and Travancore, the other three species or subspecies are endemic in the State.

Sicyopterus griseus (Day).

1878. *Sicydium griseum*, Day, *Journ. Linn. Soc. London* (Zool.) XIII, p. 140.
1878. *Sicydium griseum*, Day, *Fish. India* (Addenda and Corrigenda), p. 747.
1889. *Sicydium griseum*, Day, *Faun. Brit. Ind.* Fish. II, p. 273.
1941. *Sicyopterus griseus*, Koumans, *Mem. Ind. Mus.* XIII, p. 296.

D. 6|1/9-10; A. 1/9-10; P. 16-17; V. 6; C. 13|-; L. l. 76-82; L. tr. 25-27.

Sicyopterus griseus is a stoutly built species in which the head and the anterior part of the body are slightly depressed or subcylindrical while the tail portion is compressed. The height of the body is contained from 4·82 to 5·48 times in the standard length and from 5·68 to 6·60 times in the length with the caudal fin. The head is depressed and



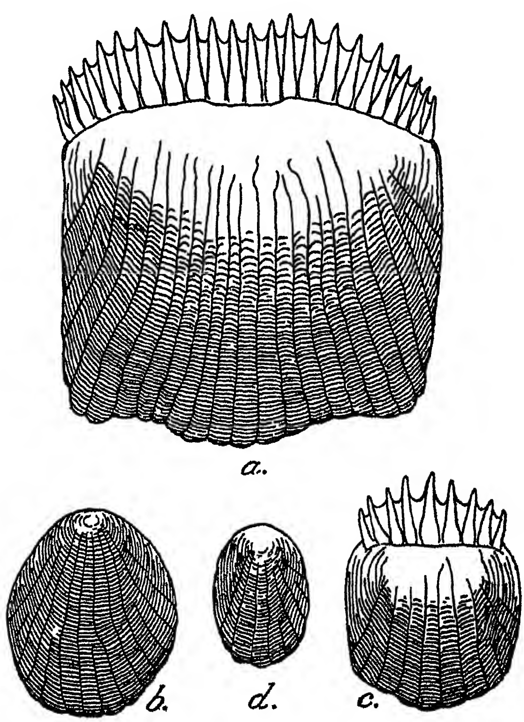
TEXT-FIG. 1.—*Sicyopterus griseus* (Day).

a. Lateral view: ×1½; *b*. Dorsal surface of head and anterior part of body: ×1⅓; *c*. Ventral surface of head and anterior part of body: ×1½; *d*. A median tooth from the upper jaw: ×25.

flattened both above and below; its width is greater than its height. The length of the head is contained from 4·18 to 4·83 times in the standard length and from 5·04 to 5·78 times in the total length. The width of the head is contained from 1·08 to 1·32 times and its height from 1·49 to 1·69 times in its length. The eyes are situated dorso-laterally almost

[1] Day, F., *Fish. India*, p. 703 (1878).
[2] Prashad, B. and Mukerji, D. D., *Rec. Ind. Mus.* XXXI, p. 223 (1929).

in the anterior half of the head; the superior border of the orbit projects beyond the dorsal profile. The diameter of the eye is contained from 5·06 to 5·40 times in the length of the head and from 2·10 to 2·39 times in the interorbital width. The interorbital space is broad and slightly concave. The snout is obtuse and overhangs the mouth. The mouth is small, inferior, crescentic and horizontal; it is bordered by thick lips which are continuous at the angles of the mouth but the labial groove is widely interrupted. The anterior lip is covered by the rostral fold which is broadly fimbriated. The jaws are subequal and the maxillary extends to below the anterior border of the eye. The teeth in the lower jaw are sharp, arranged in a series, and recurved; a short space in the middle between the two canines is toothless while behind the canines the teeth are of irregular sizes, the larger ones being either near the canines or the posterior ends of the jaw. In the upper jaw there is a single moveable row of fine, hooked teeth which are embedded in the gum. The gill-openings are vertical and almost co-extensive with the bases of the pectoral fins.



TEXT-FIG. 2.—Scales of *Sicyopterus griseus* (Day): ×36.

a. A scale from the middle of the body behind the dorsal and anal fins; *b.* A scale from in front of the first dorsal fin; *c.* A scale from the middle of the body below the first dorsal fin; *d.* A scale from the ventral surface behind the pelvic fins.

The spines of the first dorsal are filiform and project beyond the membrane; the first and the second spines are considerably elongated and extend beyond the commencement of the second dorsal. The pectoral fin is pointed while the caudal fin is rounded. The second dorsal and the anal fins are similar, being low and of moderate length. The

pelvic fins form a strong muscular sucker. Mr. S. Jones noticed that the fish can adhere very firmly by means of these fins. The caudal fin is shorter than the head and is contained from 5·7 to 6·7 times in the total length. The caudal peduncle is contained from 1·32 to 1·77 times in its length.

The scales are small and somewhat irregularly arranged, those in the tail region are considerably larger and more strongly ctenoid. The scales on the ventral surface and on the dorsal surface in front of the dorsal fin are greatly reduced and are more or less cycloid; they extend on the head almost as far as the eyes but are absent on the cheeks. The number of predorsal scales varies from 30 to 31

According to Day, the colour is "Brownish, with eight or nine rings of a darker tint encircling the body, and wider than the ground colour. *Fins*—dark, most deeply so at their edges". Day seems to have overlooked the fact that in the case of the pectoral, anal and caudal fins the dark band near the edges of the fins is followed by a white fringe, which in the case of anal is not easily distinguishable when the fin is depressed. The dorsal and lateral surfaces as well as the dorsals, middle parts of the pectoral and caudal fins are grayish, while the ventral surface and the pelvic and anal fins along with the edges of the pectoral and caudal fins are much lighter. The body is usually encircled by a number of broad, darker bands which become indistinct when the specimens are taken out of spirit.

Distribution.—South Canara and Travancore.

General Observations.– *Sicyopterus griseus* inhabits torrential streams, and its general body form and structure of the lips, rostral fold and pelvic fins are well adapted for combating strong currents. Mr. S. Jones observed that in nature the fish sticks very fast to rocks and stones, and can even adhere to the vertical sides of an aquarium above the water level like fishes of the genera *Periophthalmus* and *Periophthalmodon*.

S. griseus is distinguished from the other Indian species of the genus by its smaller scales, entire upper lip and fringed rostral fold.

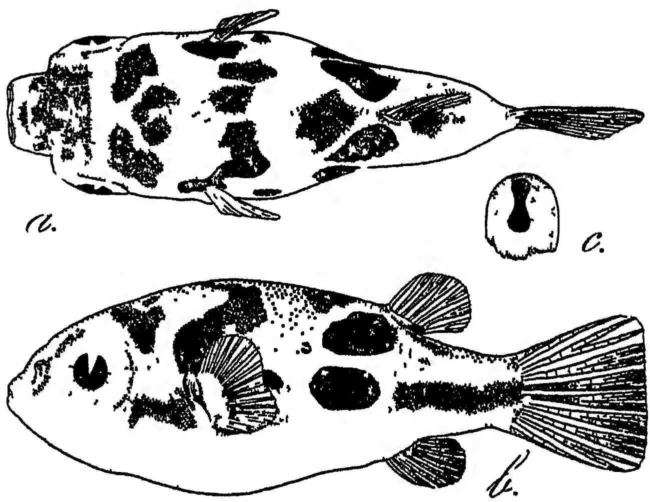
Measurements in millimetres, scale counts and number of fin rays.

Total length	84·0	86·4	87·8	88·0	97·8
Length of caudal	12·6	14·6	15·4	14·5	15·3
Depth of body	14·8	13·5	15·0	13·4	15·2
Length of head	16·7	16·2	17·3	15 2	17·2
Width of head	13·9	12·3	14·0	13·0	15·9
Height of head	11 2	10 9	10·9	10·2	10·2
Diameter of eye	3·2	3·0	3·3	3·0	3·3
Interorbital distance	7·2	6 3	7 0	6·8	7·9
Length of caudal peduncle	12·0	12·4	12·9	13·2	15·9
Least height of caudal peduncle	8·0	8·2	9·8	8·2	9·0
Longest ray of first dorsal	21·0	19·4	24·0	21·4	26·2
Length of pectoral	14·4	13·8	16 3	15·0	15·6
Length of ventral	9·2	10·0	10·6	10·5	10·1
Length of anal	8·0	7·8	10·2	9·8	9·6
Number of rays in dorsals	6|1/10	6|1/10	6|1/9	6|1/10	6|1/10
Number of rays in pectoral	17	17	17	16	17
Number of rays in ventral	6	6	6	6	6
Number of rays in anal	1/10	1/10	1/9	1/9	1/10
Number of rays in caudal	13	13	13	13	13
Number of scales along lateral line	78	81	82	76	78
Number of scales in a transverse series	27	25	25	26	25
Number of predorsal scales	31	30	30	30	30

Tetraodon (Monotretus) travancoricus, sp. nov.

D. 7-8 ; A. 8 , P. 16-17 ; V. 0.; C. 9.

Monotretus travancoricus is a small species less than an inch in total length. When inflated, it is about one-third as high as long and its width is considerably less than its height. Both the dorsal and the ventral profiles are greatly arched, but the dorsal is more so with the result that the mouth is situated in the lower half of the fish and not in the centre. The length of the head is more or less equal to the depth



TEXT-FIG. 3. *Tetraodon (Monotretus) travancoricus*, sp. nov.

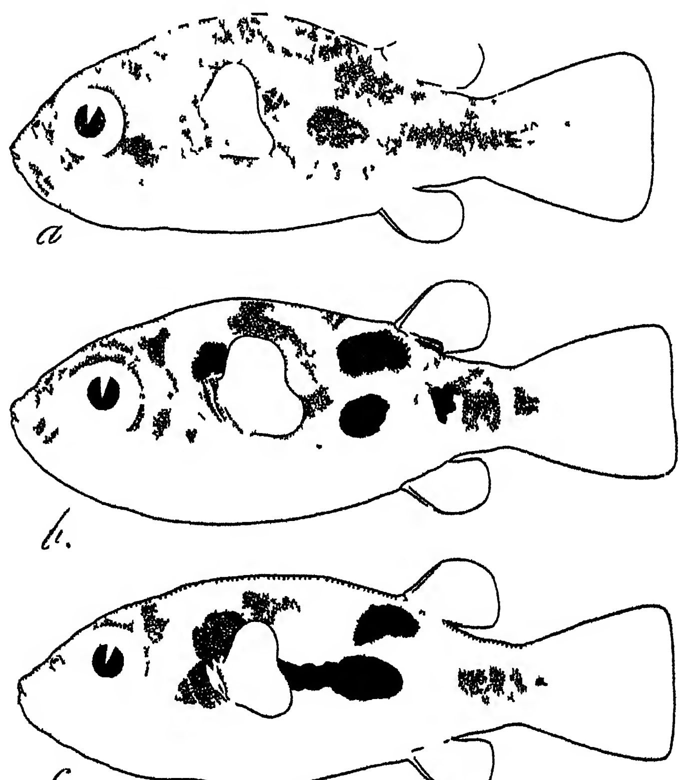
a. Lateral view of type-specimen : × 5 ; *b.* Dorsal view of same. × 5 ; *c.* Form of nasal opening of same : × 16.

of the body and is contained from 3·06 to 3·26 times in the total length and from 2·39 to 2·50 times in the standard length. The height of the head is somewhat greater than its width and is contained from 1·08 to 1·17 times in its length ; the width of the head is contained from 1·25 to 1·33 times in the length of the head. The eyes are large and lateral in position, and are situated almost in the middle of the head ; they are covered by adipose eyelids ; the diameter of the eye is contained from 2·36 to 2·69 times in the length of the head and from 0·93 to 1·04 times in the interorbital width. The interorbital space is flattened. The nostrils are represented by simple, solitary tubes, one on each side close to the anterior border of the eye. The lips of the tube are slightly curved inwards in the middle as short flaps. The mouth is small and surrounded by fleshy lips which form a tubular orifice ; the jaws are provided with median sutures. The gill-openings are small and restricted opposite to the bases of the pectoral fins.

The body is devoid of spinous outgrowths but there is a fine reticulation all over the surface. The depth of the body is contained from 2·93 to 3·33 times in the total length and from 2·21 to 2·58 times in the standard length. The caudal peduncle is well formed ; its least height is contained from 1·12 to 1·35 times in its length.

The dorsal and the anal fins are similar and situated opposite to each other in the posterior third of the body length. The distance between the gill opening and the commencement of the dorsal fin is almost equal to the length of the head. The pectoral fin is short, slightly emarginate and fan shaped. The caudal fin is well formed and truncate; its length is contained from 4.08 to 4.59 times in the total length.

The colour in spirit is grayish on the dorsal surface and sides and much lighter on the ventral surface. There are usually two black,



TEXT-FIG. 4.—Lateral views of the three paratypes of *Tetraodon* (*Monotretus*) *travancoricus*, sp. nov., showing variations in colour pattern. 5.

oval patches on the upper lateral surface of the body in front of the dorsal fin; these are situated in an area of much lighter colour. Behind this light area, there is a dark, broad band running to the caudal fin and continued for some distance on its central rays. There is usually a dark spot in the middle of its course and another at the base of the caudal fin. There is also a dark spot at the base of the last two dorsal rays. A prominent dark patch above the pectoral fin and a spot behind it are also characteristic features of the species. Along the dorsal surface, there is a narrow, light band between the eyes, two irregular patches behind the eyes which do not meet in the middle line and followed posteriorly by a V-shaped marking. Between the V-shaped marking and the dorsal fin there is another irregular band across the dorsal surface and

triangular patches in front of and behind the dorsal fin The fins are without any markings

From the specimens examined it seems that the colouration varies considerably and no two specimens are alike in this respect In order to give an idea of the variation in colouration the lateral views of three other specimens are given (text-fig 1)

Locality —Pamba River, Central Travancore

On an enquiry regarding the maximum size of the fish, Mr K Bhaskaran Nair wrote as follows

As regards the maximum size of the fish I do not think that it grows any bigger than the specimens I have sent you I have on innumerable occasions seen the catches of fishermen in the locality and have never come across bigger ones Neither has any one else there As the fish is very well known to them because it is such a favourite of children I am sure bigger specimens if there were any would not have been overlooked

Type specimen F 13601/1 Zoological Survey of India (*Ind Mus*) Calcutta

Relationships —In the following table we give a list of points in which the new species differs from *M cutcutia* (Hamilton).

Monotretus cutcutia (Hamilton)	*Monotretus travancoricus* sp nov
1 D 10 11 P 21 A 10 C 7	D 7 8 P 16 17 A 8 C 9
2 Caudal fin is contained 6 times in total length	Caudal fin is contained 4 to 4.5 times in total length
3 Eyes slightly behind the middle of the length of the head	Eyes in the middle of the length of the head
4 Interorbital space flat and broad	Interorbital space flat but not very broad
5 All the fins are rounded	The pectorals are slightly emarginate and the caudal is almost truncate
6 Greenish yellow above becoming white on the abdomen A light band passes from eye to eye A large black ocellus surrounded by a light edge on the side anterior to the origin of the dorsal and anal fins The whole of the back marked with dark greenish reticulations enclosing lighter spaces fins grayish caudal tipped with carmine a red spot on the throat	Dull greenish yellow above and yellowish below A light band between the eyes There are varying numbers of dark patches surrounded by lighter areas on the dorsal and lateral sides and there are no reticulations Fins without markings except the middle rays of the caudal fin
7 Maximum size about 3½ inches	Maximum size about an inch

Measurements in millimetres and number of fin rays

Total length	20.8	21.1	21.5	21.8	22.0
Caudal length	5.1	4.6	5.0	5.1	5.0
Depth of body	7.1	6.7	7.1	6.7	6.6
Length of head	6.7	6.9	6.6	6.8	7.0
Width of head	5.3	5.2	5.3	5.3	5.4
Height of head	5.9	6.0	6.1	5.8	6.0
Diameter of eye	2.6	2.6	2.8	2.6	2.6
Interorbital distance	2.5	2.4	2.8	2.7	2.2
Length of caudal peduncle	3.1	2.9	3.4	3.1	2.9
Least height of caudal peduncle	2.3	2.2	2.7	2.6	2.6
Distance between gill opening and commencement of dorsal fin	6.8	6.6	6.7	6.8	7.1
Longest ray of dorsal fin	2.4	2.2	2.2	2.1	2.5
Length of pectoral fin	2.2	2.1	2.1	2.0	2.8
Length of anal fin	2.3	2.2	2.2	2.2	2.2
Number of rays in dorsal fin	8	8	7	8	8
Number of rays in pectoral fin	17	17	17	17	16
Number of rays in anal fin	8	8	8	8	8
Number of rays in caudal fin	9	9	9	9	9

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CYCLOPIDES (CRUSTACÉS COPÉPODES) DE L'INDE. VI, VII.

Par Knut Lindberg.

VI. Contribution à la connaissance de *Cyclops viridis* (Jurine).

Le *Cyclops viridis*, espèce palé-et néarctique de répartition géographique presque générale dans l'hémisphère nord, a, pendant ces dernières années, été trouvé aussi dans des régions tropicales, en Abyssinie (Lowndes 1930) et à Java (Kiefer 1930). Dans le Nord de l'Iran il est un des Cyclopides les plus communs, et il se voit également dans le Sud, même dans les parties torrides du pays, près du golfe Iranien. Ces contrées étant limitrophes de l'Inde quelques notes et des figures sont données ici sur ces animaux. Jusqu'à présent je n'ai récolté le *C. viridis* nulle part au cours de mes pêches dans l'Ouest et le Sud de l'Inde, et, pour autant qu'il me soit connu, il n'a été rapporté que de Tchitral, près de la frontière de l'Afghanistan, et de Cachemire (Gurney 1906, Kiefer 1939). Cependant il semble bien possible qu'il pourra se rencontrer aussi dans les régions montagneuses du Sud de la péninsule Indienne.

Femelle.—Longueur (sans soies apicales) de 1567 à 2375 μ (moyenne 1965 μ) ; largeur de 632 à 922 μ (moyenne 782 μ). Configuration des ailes latérales du quatrième et cinquième segments thoraciques et du

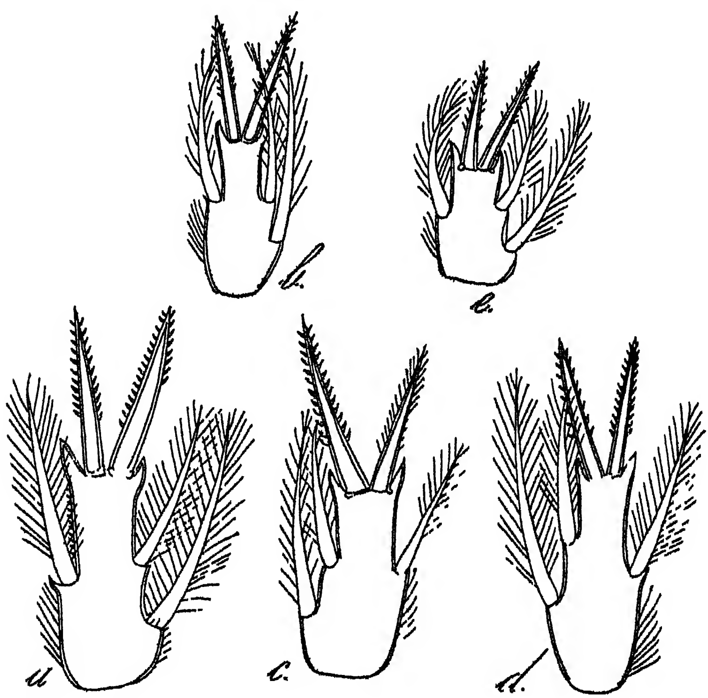

FIG. 1. *Cyclops viridis* (Jurine) ♀ Article terminal de l'endopodite de P 4. *a.* Recht, mare ; *b.* Recht, fosse ; *c.* Chahi, fosse ; *d.* Abadan, fosse ; *e.* Khorramchahr, mare.

segment génital semblable à celle des animaux européens. Branches de la furca divergentes, à rebord interne toujours muni de cils, de 2·82 à 4·16 fois aussi longues que larges (rapport moyen 3·24 : 1). Soie dorsale un peu moins longue que la soie apicale externe. Celle-ci moins que la moitié de la longueur de la soie apicale interne. Première antenne à 17 articles ; rabattue elle atteint le tiers postérieur du premier segment céphalothoracique ; chez aucun spécimen examiné je ne l'ai vu atteindre le bord postérieur de ce segment. Formule des épines 2.3.3.3. Article terminal de l'endopodite de P 4 environ deux fois aussi long que large, ce rapport variant de 1·70 : 1 à 2·49 : 1. Epine apicale interne le plus souvent nettement plus longue que l'épine apicale externe et presque toujours inférieure en longueur à celle de l'article. Chez deux spécimens

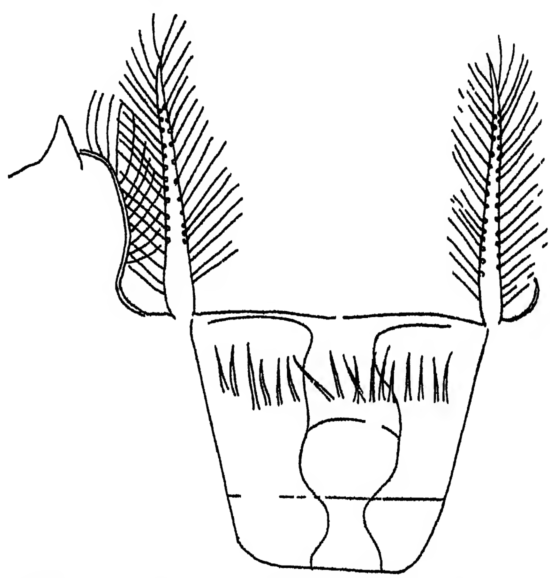

FIG. 2. *Cyclops viridis* (Jurine) ♀ Lamelle basale de P 4. Recht, marc.

seulement l'épine apicale externe surpassait en longueur celle de l'épine apicale interne. Un animal avait l'article et l'épine apicale interne de longueur égale et chez un individu l'article était un peu plus court que l'épine apicale interne. Soies n'atteignant pas l'extrémité des épines apicales. P 5 montrant une grande variabilité tant dans la forme et les dimensions des deux articles, que dans la structure et la position de l'épine du rebord interne du deuxième article, celle-ci étant parfois minuscule, d'autres fois longue et forte (subsp. "*acutulus*" Kiefer). Elle peut être, soudée à l'article sans trait d'union visible, ou présenter une articulation ; le plus souvent elle se trouve un peu au-delà du milieu de l'article, mais quelquefois elle semble très rapprochée de son extrémité (var. "*deserticola*" Lindberg). Une structure variable de cette épine s'observe chez des animaux provenant d'une même récolte et parfois chez un même individu en comparant les deux côtés, et je ne considère plus justifié la distinction de la variété *deserticola*, décrite en 1936, et je ne vois pas de raisons pour séparer les animaux à longue épine comme appartenant à une sous espèce distincte. Réceptacle

séminal semblant offrir une configuration assez variable, mais il est souvent difficile à distinguer d'une facon satisfaisante. Ovisacs en

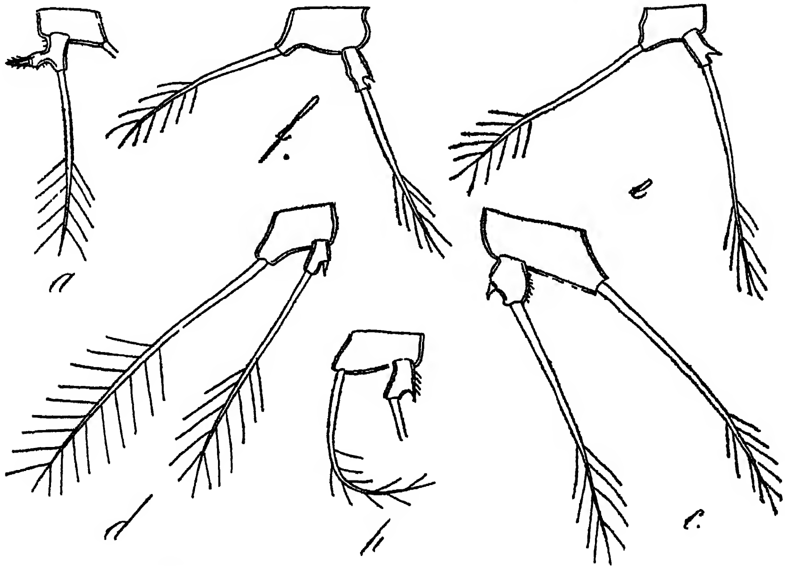

FIG. 3. *Cyclops viridis* (Jurine) ♀ P 5. *a*. Côté gauche (tératologique) Recht, fosse ; *b*. Même individu, côté droit ; *c*. Recht, mare ; *d*. Chahi, fosse ; *e*. Lahidjan, petite rivière ; *f*. Abadan, fosse.

général très grands et allongés, écartés du corps. J'ai compté un minimum de 24 oeufs dans un sac, et un maximum de 96. Le plus souvent ils renfermaient chacun de 50 à 65 oeufs.

Mâle.—Longueur (sans soies apicales) de 1064 à 1482 μ (moyenne 1257 μ) ; largeur de 437 à 570 μ (moyenne 494 μ). Branches de la furca le plus souvent légèrement divergentes, quelquefois parallèles, à bord interne cilié ; elles sont en général un peu moins longues que chez la femelle (rapport moyen, longueur : largeur 2·89 : 1). Article terminal de l'endopodite de P 4 et de ses épines apicales assez comparables dans leurs rapports de longueur avec ceux de la femelle. P 5 de structure variable. P 6 formée d'une forte épine interne qui le plus souvent n'atteint pas le bord postérieur du deuxième segment abdominal, mais peut d'autres fois le dépasser largement ; d'une soie médiane ciliée plus courte ou de longueur à peu près égale à celle de l'épine, et d'une longue soie externe munie de cils espacés.

Les dessins ont tous été exécutés à la même échelle, de sorte que les proportions des parties dessinées sont directement comparables.

Habitats.—Tchitral (Gurney 1906) ; Cachemire, plusieurs localités ; marécage, mares et étang, à des altitudes au-dessus du niveau de la mer allant de 1585 à 4491 mètres (Kiefer 1939). Provinces Caspiennes : Baboul, ruisseau ; Chahi, fosses, étang, mares ; Gorgan, bassin ; Lahidjan, fosses, mare, étang de l'Institut agricole, petite rivièrs, rizière ; Langueroud, mare ; Pahlévi, mare ; Pahlevi (Ghazian), mares, puits, étang ; Ramsar, mares, trou d'eau, marécage, petit étang ; Recht, mares, ruisseau, fosse.

Plateau : Broudjerd, étang (1935) ; Chiraz, bassins ; Firouzabad, bassin ; Isfahan, puits ; Qazvin, bassins ; Robat-Khan (Decht-Lout) petit étang salin (1935).

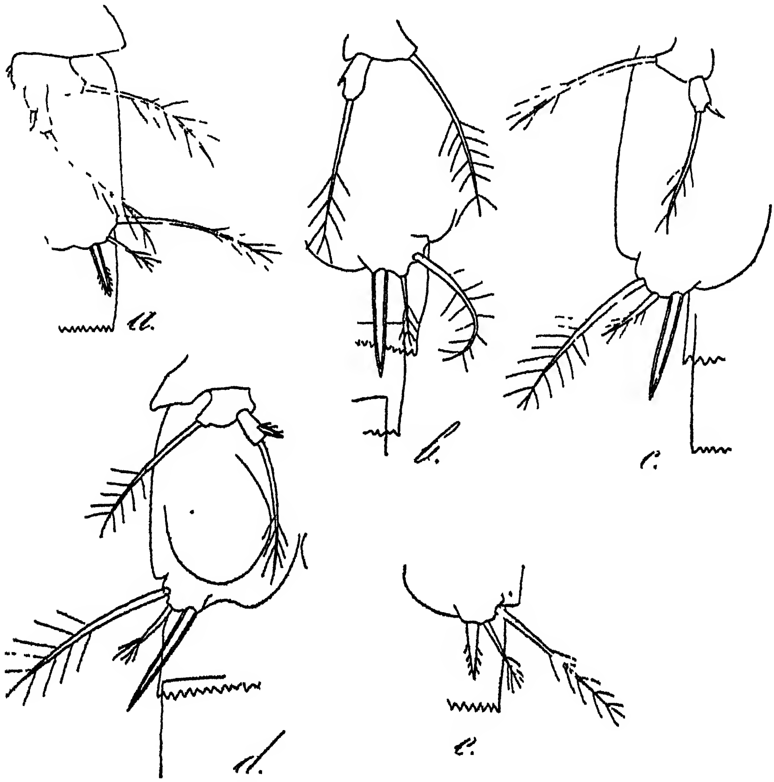

FIG. 4. *Cyclops viridis* (Jurine) ♂ P 5 et P 6. *a.* Lahidjan, fosse ; *b.* Pahlévi (Ghazian), mare ; *c.* Ramsar, petit étang ; *d.* Ramsar, marécage ; *e.* Recht, fosse.

Golfe Iranien et Khouzistan : Abadan, fosses dans plantations de dattiers ; Khorramchahr, fosses, petite mare ; Chouch (Suse), fosse près de la gare, marécage près du village.

Des 249 échantillons contenant des Cyclopides (105 du Nord, 144 du Sud de l'Iran) rapportés de mes voyages en 1939-40, le *C. viridis* se trouvait dans 41 (32 du Nord, 9 du Sud), provenant de 15 localités différentes (9 du Nord, 6 du Sud).

SOMMAIRE.

Vingt neuf femelles et 20 mâles adultes de *Cyclops viridis* (Jurine) ont été étudiés, et la variabilité de certaines parties d'importance diagnostique, notamment de l'article 3 de l'endopodite de P 4, de P 5 et de P 6 du mâle, a été montrée par des mensurations et des figures. Ces variabilités sont considérables, mais leur observation chez des animaux d'une même pêche (représentant peut-être dans quelques cas une seule population), et l'existence de formes de passage, ne semblent pas justifier la distinction de sous-espèces ou de variétés.

Cyclops viridis (Jurine) ♀.

Localité.	Longueur.	Furca.	Soie dorsale.	Soie apic. int. : soie apic. ext.	Enp. 4 Long. : larg.	Enp. 4 Ep. ap. int. : ép. ap. ext.	Enp. 4 Long. art : ép. ap. int.
Chahi—							
Fosse	1701	(112+38) : 47=3·19 : 1	112	300 : 130=2·30 : 1	113 : 55=2·05 : 1	117 : 100=1·17 :1	0·97 : 1
Mare	1815	(111+43) : 50=3·14 : 1	122	317 : 127=2·49 : 1	117 : 52=2·25 : 1	107 : 89=1·20 . 1	1·09 : 1
Autre mare	1881	(120+42) : 50=3·36 : 1	150	320 : 145=2·22 : 1	122 : 54=2·26 : 1	122 . 108=1·13 : 1	1 : 1
Lahidjan—							
Fosse	1729	(97+45) . 42=3·45 : 1	97	257 : 120—2·14 : 1	87 : 50=1·74 : 1	83 : 68=1·22 : 1	1·05 : 1
Petite rivière	1976	(115+38) : 50=3·06 : 1	132	289 . 142=2·03 : 1	120 : 57=2·10 : 1	108 : 94=1·15 : 1	1·11 : 1
Fosse	1767	(105+37) : 48=2·96 : 1	120	284 : 130=2·19 . 1	103 : 48=2·15 : 1	100 : 80=1·25 : 1	1·03 : 1
Mare	1606	(88+42) : 45=2·89 : 1	..	x : 105= x : 1	92 : 47=1·96 : 1	76 : 59=1·29 : 1	1·21 : 1
Fosse	2071	(133+42) : 62=2·82 : 1	150	379 : 153=2·48 : 1	133 : 65=2·05 : 1	110 : 92=1·19 : 1	1·21 : 1
Etang	1691	(105+35) : 47=2·98 . 1	108	284 : 113=2·51 : 1	97 : 52=1·87 . 1	87 . 72=1·20 : 1	1·11 : 1
Rizière	1610	(99+48) : 50=2·94 : 1	. 117	270 : 132—2·05 : 1	102 : 52=1·96 : 1	100 . 80=1·25 . 1	1·02 : 1
Languerout—							
Mare	2375	(123+50) : 58=2·98 : 1	134	342 : 147=2·33 : 1	130 : 55=2·36 : 1	112 : 100=1·12 . 1	1·16 : 1
Pahlevi (Ghazian)—							
Puits	1581	(139+40) : 43=4·16 : 1	..	275 117=2·35 : 1	105 . 50=2·10 : 1	....	..
Mare	2318	(150+67) : 62=3·50 : 1	125	355 : 167=2·13 . 1	140 : 65=2·15 : 1	80 . 88=0·91 : 1	1·75 : 1
Autre mare	2156	(167+58) : 65=3·46 : 1	178	367 . 178=2·06 : 1	143 : 67=2·13 : 1	108 103=1·05 . 1	1·32 : 1
Etang	2166	(124+48) : 58=2·98 : 1	123	362 : 158=2·29 : 1	130 : 57=2·28 . 1	119 . 117=1·02 . 1	1·09 : 1

Cyclops viridis (Jurine) ♀ (suite).

Localité.	Longueur.	Furca.	Soie dorsale.	Soie. Apic. int. : soie apic. ext.	Dnp. 5 Long. : larg.	Enp. 4 Ep. ap. int. : ép. ap. ext.	Edp. 4 Long. art: ép. sp. int.
Ramsár—							
Petite étang	2308	(150+42) : 57=3·37 : 1	127	347 : 164=2·12 : 1	127 : 62=2·05 : 1	109 : 107=1·02 : 1	1·17 : 1
Trou d'eau	2118	(136+48) : 53=3·47 : 1	128	337 : 158=2·13 : 1	117 : 58=2·02 : 1	95 : 93=1·02 : 1	1·23 : 1
Mare	2109	189 : 52=3·63 : 1	137	334 : 167=2·1 : 1	117 : 62=1·89 : 1	103 : 105=0·98 : 1	1·13 : 1
Marécage	1995	(127+45) : 58=2·96 : 1	128	307 : 142=2·16 : 1	112 : 53=2·11 : 1	90 : 86=1·05 : 1	1·24 : 1
Recht—							
Ruisseau	1935	(108+50) : 48=3·29 : 1	110	275 : 125=2·20 : 1	97 : 50=1·94 : 1	91 : 72=1·26 : 1	1·07 : 1
Mare	1696	(112+38) : 45=3·33 : 1	103	270 : 112=2·41 : 1	103 : 47=2·19 : 1	85 : 75=1·13 : 1	1·21 : 1
Fosse	1615	(100+42) : 47=3·02 : 1	107	267 : 117=2·28 : 1	90 : 48=1·87 : 1	83 : 78=1·06 : 1	1·08 : 1
	1718	(111+42) : 48=3·19 : 1	110	289 : 128=2·26 : 1	100 : 55=1·82 : 1	88 : 75=1·17 : 1	1·14 : 1
Mare	2147	(131+58) : 58=3·31 : 1	142	357 : 167=2·14 : 1	137 : 57=2·40 : 1	120 : 105=1·14 : 1	1·14 : 1
Isfahan—							
Puits	2176	(145+55) : 57=3·50 : 1	125	351 : 164=2·14 : 1	137 : 55=2·49 : 1	112 : 101=1·11 : 1	1·22 : 1
Abadan—							
Fosse	2366	(149+60) : 58=3·60 : 1	120	334 : 150=2·23 : 1	132 : 65=2·03 : 1	103 : 98=1·05 : 1	1·25 : 1
Khorramchahr—							
Petite mare	1567	(105+47) : 47=3·23 : 1	103	259 : 112=2·31 : 1	85 : 50=1·70 : 1	80 : 75=1·07 : 1	1·06 : 1
Suse—							
Marécage	1967	(118+45) : 55=2·96 : 1	105	317 : 130=2·44 : 1	120 : 61=1·97 : 1	112 : 107=1·05 : 1	1·07 : 1

Cyclops viridis (Jurine) ♂.

Localité.	Longueur.	Furca.	Soie dorsale.	Soie apic. int. : soie apic. ext.	Enp. 4 Long. : larg.	Enp. 4. Ep. ap. int. : ep. ap. ext.	Enp. 4. Long. art. : ep. ap. int.	P 6 Epine : soie méd. : soie ext.
Chahi—								
Fosse	1092	88 : 32=2·75 : 1	92	230 : 108=2·13 : 1	75 : 34=2·20 : 1	80 : 72=1·11 : 1	0·94 : 1	53 : 47 : 122
Mare	1254	97 : 33=2·93 : 1	85	269 : 112=2·40 : 1	90 : 39=2·31 : 1	92 : 75=1·23 : 1	0·98 : 1	57 : 43 : 105
Lahidjan—								
Fosse	1112	90 : 33=2·73 : 1	87	204 : 87=2·34 : 1	88 : 50=1·76 : 1	88 : 75=1·17 : 1	1 : 1	37 : 37 : 108
Petite rivière	1283	95 : 38=2·50 : 1	..	284 : 117=2·43 : 1	88 : 42=2·09 : 1	78 : 67=1·16 : 1	1·13 : 1	45 : 35 : 113
Fosse	1092	92 : 33=2·78 : 1	..	..	70 : 36=1·94 : 1	70 : 60=1·17 : 1	1 : 1	38 : 38 : x
Mare	1140	98 : 30=3·26 : 1	83	205 : 92=2·23 : 1	70 : 33=2·12 : 1	65 : 53=1·23 : 1	1·08 : 1	33 : 42 : 100
Fosse	1349	100 : 38=2·63 : 1	92	274 : 123=2·23 : 1	92 : 42=2·19 : 1	81 : 75=1·08 : 1	1·14 : 1	42 : 47 : 122
Etang	1074	88 : 29=3·03 : 1	88	210 : 83=2·53 : 1	68 : 36=1·89 : 1	65 : 50=1·30 : 1	1·05 : 1	35 : 37 : 88
Rizière	1178	88 : 33=2·67 : 1	92	232 : 98=2·37 : 1	75 : 38=1·97 : 1	76 : 65=1·17 : 1	0·99 : 1	42 : 38 : 112
Langueroud—								
Mare	1444	..	..	..	..	..	..	63 : 40 : x
Pahlévi (Ghazian)—								
Mare	1452	117 : 40=2·92 : 1	92	300 : 128=2·34 : 1	107 : 42=2·55 : 1	92 : 75=1·23 : 1	1·16 : 1	72 : 47 : 107
Etang	1430	108 : 37=2·92 : 1	117	287 : 133=2·16 : 1	100 : 42=2·38 : 1	83 : 70=1·19 : 1	1·20 : 1	68 : 50 : 108

Cyclops viridis (Jurine) ♂ (suite).

Localité.	Longueuer.	Furco.	Sole dorsale.	Soie apic. int. : soie opic. ext.	Enp. 4 Lodg. : larg.	Enp. 4. Ep. ap. int. : ep. ap. ext.	Enp. 4 Long art : ep. ap. int.	P 6 Epine : soie med : soie ext.
Ramsar—								
Petit étang	1320	112 : 37=3·03 : 1	..	225 : 103=2·18 : 1	87 : 43=2·02 : 1	79 : 73=1·08 : 1	1·10 : 1	58 : 42 : 97
Trou d'eau	1302	103 : 36=2·86 : 1	83	242 : 112=2·16 : 1	83 : 35=2·37 : 1	80 : 67=1·19 : 1	1·04 . 1	62 . 50 . 103
Marécage	..	..	..	..	..	..	..	..
Recht—								
Fosse	1149	92 : 33=2·78 : 1	83	x : 97= x : 1	73 : 37=1·97 : 1	67 : 55=1·22 : 1	1·09 : 1	33 : 33 : 100
Isfahan—								
Puits	1330	117 : 38=3·08 : 1	88	250 : 113=2·26 : 1	88 : 40=2·20 : 1	83 : 67=1·24 : 1	1 06 : 1	52 : 33 : 117
Abadan—								
Fosse	1302	113 : 37=3·05 : 1	..	..	83 : 40=2·07 : 1	80 : 67=1·19 : 1	1·04 : 1	42 : 33 : 92
Khorramchahr—								
Petite mare	1140	95 . 35=2·71 : 1	..	217 : 90=2·41 : 1	82 : 40=2·05 : 1	75 : 62=1·21 . 1	1 09 : 1	42 : 33 : 100
Fosse	1349	113 . 33=3·42 . 1	87	250 : 93=2·69 : 1	81 : 42=1·93 : 1	77 : 67=1·15 . 1	1·05 : 1	40 . 33 : 95
Suse—								
Marécage	1254	88 : 32=2·75 : 1	78	234 : 87=2·46 : 1	77 : 37=2·08 : 1	75 : 63=1·19 1	1·03 : 1	34 : 32 : 90

VII. NOTES SUR DES MEMBRES INDIENS ET IRANIENS DU GENRE *MACROCYCLOPS* Claus.

Macrocyclops fuscus Jurine.

Description.—Femelle (4 individus examinés). Longueur, sans soies apicales, de 1425 à 1900 μ ; largeur de 608 à 722 μ. Branches de la furca divergentes, à rebord interne cilié, de 2·08 à 2·64 fois aussi longues que larges. Soie latérale externe insérée près de l'extrémité. Soie dorsale plus courte que la soie apicale externe. Les deux soies apicales médianes très longues. Première antenne à 17 articles ; rabattue elle atteint le milieu du troisième segment thoracique. Trois derniers articles munis d'une membrane hyaline qui, au niveau de la moitié proximale du dix-septième article, est grossièrement denticulée. J'ai compté

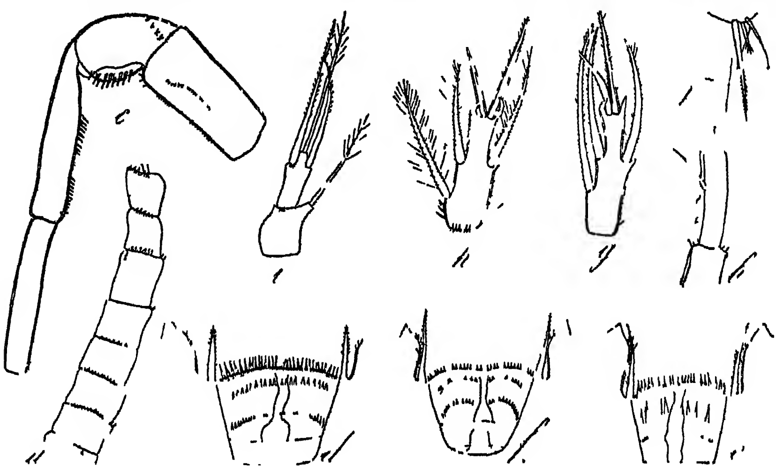

FIG. 5. *Macrocyclops fuscus* Jurine. *a.* ♀ Première antenne, articles 8 à 14 (Chahi, étang) ; *b.* ♀ Première antenne, article 17 (mare) ; *c.* ♀ Deuxième antenne (étang) *d.* ♀ Lamelle basale de P 4 (mare) ; *e.* ♀ Lamelle basale de P 4 (étang) ; *f.* ♀ Lamelle basale de P 4 (étang) ; *g.* Article 3 de P 4 (étang) ; *h.* ♀ Article 3 de P 4 (mare) ; *i.* ♀ P 5 (fosse) ; *j.* ♂ P 6 (mare).

de 9 à 16 denticules à ce niveau. Deuxième antenne longue ; premier, quatrième et surtout troisième articles très allongés, surpassant de beaucoup la longueur du deuxième article. Article 3 de l'enp. 4 environ 3 fois aussi long que large ; épine apicale interne plus courte que l'épine apicale externe et de même beaucoup moins longue que l'article. Epine interne du deuxième article de P 5 considérablement plus longue que l'épine externe de cet article. Ovisacs assez petits, accolés, renfermant chacun de 13 à 25 oeufs.

Mâle.—Un seul spécimen. Longueur 1202 μ ; largeur 523 μ. Branches de la furca parallèles, à rebord interne cilié, relativement un peu plus courtes que celles de la femelle. P 6 formée d'une forte épine interne, dont l'extrémité dépassait le bord postérieur du troisième segment abdominal, d'une petite soie médiane et d'une soie externe, qui était plus courte que l'épine interne.

Habitats.—Chahi (Mazendéran), mare, fosse, étang.

Déjà trouvé dans le Turkestan (Daday), le *Macrocyclops fuscus* n'avait, pour autant qu'il me soit connu, pas encore été signalé plus au

Macrocyclops fuscus Jurine.

Localité.	Longueur. μ	Antenne 2 Longueur des articles.	Furca.	Soie dorsale.	Soie apic. int. : soie apic. ext.	Art. 3. Enp. 4. Long. : larg.	Art. 3. Enp. 4. Ep. int. : ép. ext.	Art. 3. Enp. 4. Long. art. : ep. int.	P 6 Ep. : soie méd : soie ext.
Chahi—									
Mare	♀ 1900	..	(83+25) : 51=2·12 : 1	167	406 : 265=1·53 : 1	120 : 40=3 : 1	75 : 122=0·61 : 1	1·60 : 1	..
Fosse	♀ 1700	..	(114+18) : 50=2·64 : 1	200	457 : 346=1·40 : 1	117 : 38=3·08 : 1	92 : 118=0·78 : 1	1 27 : 1	..
Étang	♀ 1425	133 : 83 : 163 : 142	(65+32) : 48=2·05 : 1	162	364 : 239=1·52 : 1	120 : 37=3·24 : 1	67 : 107=0·63 : 1	1·79 : 1	..
	♀ 1545	..	(105+13) : 51=2·31 : 1	189	484 : 330=1·47 : 1	117 : 39=3 : 1	90 : 109=0·83 : 1	1·39 : 1	..
Mare	♂ 1202	..	(55+18) : 38=1·92 : 1	118	339 : 192=1·76 : 1	197 : 33=2·93 : 1	62 : 83=0·75 : 1	1·56 : 1	85 : 28 : 67

sud sur le continent asiatique. Je ne l'ai rencontré que dans une seule localité du Nord de l'Iran, dans trois biotopes différents, de caractère eutrophique.

Macrocyclops albidus Jurine.

Description.—Sept femelles adultes examinées. Longueur de 1187 à 1729 μ ; largeur de 456 à 665 μ. Branches de la furca parfois parallèles, mais le plus souvent légèrement divergentes, à bord interne glabre, de 1·81 à 2·20 fois aussi longues que larges. Soie dorsale et soie apicale externe de la furca de longueur à peu près égale. Première antenne à 17 articles ; rabattue elle atteint le milieu ou le bord postérieur du troisième segment thoracique. Articles 15, 16 et 17 munis d'une membrane hyaline qui est très finement denticulée sur le dernier article. Article 3 de la deuxième antenne plus court que chacun des trois autres articles. Article 3 de l'enp. 4 de 2·04 à 2·63 fois aussi long que large. Epine

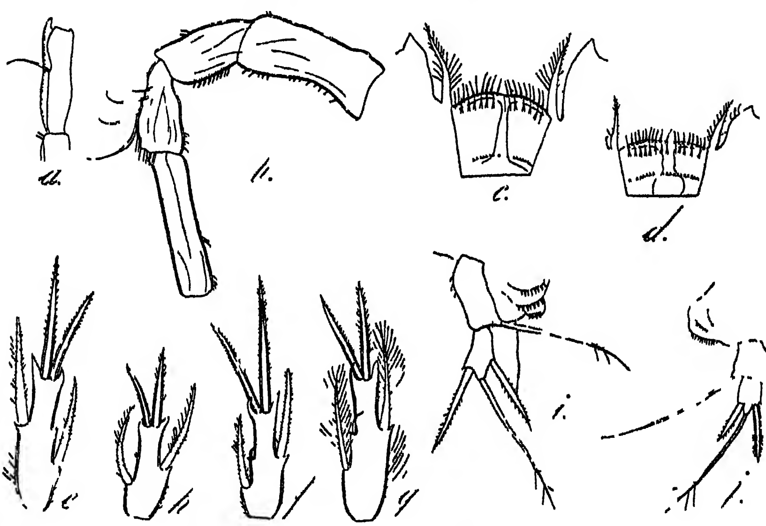

FIG. 6. *Macrocyclops albidus* Jurine. *a.* ♀ Première antenne, article 17 (Chahi mare) ; *b.* ♀ Deuxième antenne (Chahi, mare) ; *c.* ♀ Lamelle de P 4 (Chahi, fosse) ; *d.* ♀ Lamelle de P 4 (Baba Hadji ,étang) ; *e.* ♀ Article 3 de P 4 (Chahi, fosse) ; *f.* ♀ Article 3 de P 4 (Chahi, mare) ; *g.* ♀ Article 3 de P 4 (Recht, mare) ; *h.* ♀ Article 3 de P 4 (Baba Hadji, étang) ; *i.* ♀ P 5 (Recht, mare) ; *j.* ♀ P 5 (Baba Hadji, étang).

apicale interne moins longue que l'épine apicale externe et considérablement plus courte que l'article. La soie distale du rebord interne de cet article est, soit rudimentaire, soit entièrement absente (subspecies *oligolasius* de Kiefer 1928). Comme Gurney le fait remarquer cette particularité avait déjà été mentionnée par Sars en 1909. P 5 semblable à celle de l'espèce précédante. Ovisacs grands, écartés du corps ; ils étaient endommagés chez tous les animaux examinés.

Habitats.—Cette espèce cosmopolite a dans la région dont il s'agit ici, été rapportée pour la première fois de Cachemire (étang, marécages, à 1585 mètres au-dessus du niveau de la mer) par l'expédition de Yale en 1932 (Kiefer 1939). En 1935 je l'ai récoltée dans un bassin à Méchhed (Khorassan), et en 1939-40 je l'ai retrouvée dans les localités suivantes : Chahi (Mazendéran), mare du fleuve Talar, fosse près du même fleuve ;

Macrocyclops albidus Jurine ♀.

Localité.	Longueur. μ	Antenne 2 Longueur des articles.	Furca.	Soie dorsale.	Soie apic. int. : soie apic. ext.	Art. 3. Enp 4. Long. : larg.	Art. 3. Enp. 4. Ep. int. : ép ext.	Art. 3. Enp. 4. Long. art. : ép. int.
Chahi—								
Mare	1330	..	(67+20) : 41=2·12 : 1	133	351 : 120=2·92 : 1	93 : 37=2·51 : 1	75 : 93=0·80 : 1	1·22 : 1
Fosse	1377	..	(72+20) : 45=2·04 : 1	133	367 : 125=2·94 : 1	100 : 39 =2·56 : 1	80 · 100 =0·81	1·25 : 1
	1273	..	(65+22) : 48=1·81 : 1	133	337 : 117=2·88 : 1	92 : 35=2·63 : 1	78 : 99=0·79 : 1	1·18 : 1
Recht—								
Mare	1729	130 : 117 : 75 : 137	(85+25) : 50=2·20 : 1	125	364 : 153=2·38 : 1	107 : 45=2·38 . 1	78 : 93=0·84 : 1	1·37 : 1
Ramsar—								
Mare	1463	..	(83−20) : 47=2·19 : 1	..	376 : 150=2·50 : 1	105 : 41=2·56 : 1	77 : 100=0 77 : 1	1 36 : 1
Autre mare	1506	..	(55−23) : 49=2·20 : 1	133	397 : 137=2·89 : 1	92 : 45=2·04 . 1	85 : 97=0·88 : 1	1·05 : 1
Baba Hadji—								
Etang	1187	83 : 75 : 63 : 100	(58+22) : 38=2·05 : 1	117	269 : 100=2·69 : 1	85 : 39=2·18 : 1	60 : 73=0 82 : 1	1·42 : 1

Ramsar (Mazendéran) plusieurs mares ; Recht (Guilan), mares ; Baba Hadji (Fars), étang d'eau douce à 30 kilomètres au sud de Chiraz.

Macrocyclops distinctus Richard.

Description.—Femelle (3 adultes). Longueur de 1387 à 1463, μ ; largeur de 551 à 618 μ. Branches de la furca divergentes, à rebord interne cilié, de 2·29 à 2·44 fois aussi longues que larges. Soie dorsale beaucoup plus courte que la soie apicale externe. Première antenne à 17 articles, très longue ; rabattue, elle dépassait chez un spécimen le rebord postérieur du cinquième segment thoracique. Trois derniers articles pourvus d'une membrane hyaline entière. Article 3 de l'enp. 4 de 2·62 à 3·09 fois aussi long que large. Epine apicale interne en général inférieure en longueur à celle de l'épine apicale externe. Chez un individu l'épine apicale interne était un peu plus longue que l'épine apicale externe. Ovisacs allongés, écartés du corps. Un sac renfermait chez un spécimen 16 et chez un autre 18 oeufs. Couleur gris-verdâtre ou olivacée ; ovisacs foncés, brun-noirâtres.

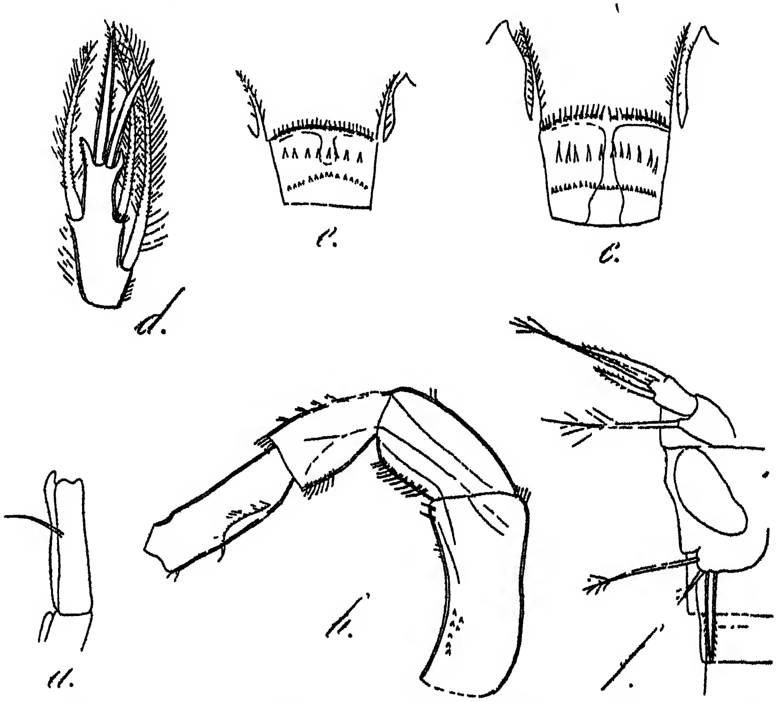

FIG. 7. *Macrocyclops distinctus* Richard. *a.* ♀ Première antenne, article 17 (Pandharpour, rivière) ; *b.* ♀ Deuxième antenne (Pandharpour, rivière) ; *c.* ♀ Lamelle basale de P 4 (Pandharpour rivière) ; *d.* ♀ Article 3 de P 4 (Pandharpour, rivière) ; *e.* ♂ Lamelle basale de P 4 (île de Salsette, rivière) ; *f.* ♂ P 5 et P 6 (île de Salsette, rivière).

Mâle.—Un seul observé. Longueur 1016 μ ; largeur 428 μ. Furca à branches parallèles, plus courtes que chez la femelle, à rebord interne cilié. Soies apicales à courbure en lyre caractéristique ; celles-ci plus courtes que celles de la femelle. P 6 à épine interne atteignant le bord postérieur du troisième segment abdominal, à soie médiane courte et à soie externe très mince.

Macrocyclops distinctus Richard.

Localité.	Longueur. μ	Antenne 2 Longueur des articles.	Furca.	Soie dorsale.	Soie apic. int. : soie apic. ext.	Art. 3. Enp. 4. Long. : larg.	Art. 3. Enp. 4. Ep. int. : ép. ext.	Art. 3. Enp. 4. Long. art. : ép. int.	P 6 En. : soie méd. : soie ext.
Pandharpour—									
Rivière Takli	♀ 1434	108 : 95 : 78 : 100	(88+20) : 47=2·29 : 1	130	370 : 237=1·56 : 1	102 : 33=3·09 : 1	75 : 83=0·90 : 1	1·36 : 1	..
	♀ 1387	..	(91+17) : 43=2·51 : 1	150	380 : 285=1·33 : 1	97 : 32=3·03 : 1	82 : 78=1·05 : 1	1·18 : 1	..
	♀ 1463	100 : 103 : 88 : 103	(99+18) : 48=2·44 : 1	170	441 : 289=1·53 : 1	102 : 39=2·62 : 1	78 : 91=0·86 : 1	1·30 : 1	..
Ile de Salsette—									
Riviere pres du lac Povai.	♂ 1016	..	(61+13) : 37=2 : 1	125	292 : 184=1·59 : 1	75 : 30=2·50 : 1	50 : 61=0·82 : 1	1·50 : 1	67 : 28 : 83

Habitats.—Rapporté du Ceylan (étang à Candy) par Gurney en 1916 et plus tard de Lahore (Pendjab). Je l'ai rencontré dans une rivière à Pandharpour (Deccan) en août 1936 (3 ♀♀) et en décembre 1938 (1 ♀) et j'ai trouvé un mâle unique dans une rivière près du lac Povaï (île de Salsette, Bombay), en décembre 1937. Dans le cas des animaux de Pandharpour et celui de l'île de Salsette il s'agit manifestement de l'espèce typique.

Kiefer a en 1932 décrit une nouvelle espèce, *Macrocyclops neuter* de Java, caractérisée notamment par la longueur de l'article 3 du deuxième antenne, et, aussi bien Kiefer que Gurney lui-même, sont d'avis que les animaux du Ceylan appartiennent à cette forme, mais Gurney considère que la distinction de *M. neuter* comme une espèce différente manque de justification.

A propos de la répartition géographique des 3 espèces mentionnées ici, il convient de remarquer que le *M. fuscus* et le *M. albidus*, connus de l'Asie centrale et de l'Iran, n'ont pas encore été trouvés dans l'Inde propre (abstraction faite du Cachemire), tandis que le *M. distinctus*, qui apparemment est répandu à travers toute la péninsule indienne, n'a jusqu'ici pas été récolté dans l'Iran, ni dans l'Asie centrale.

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ON THE OCCURRENCE OF *PROSTHOGONIMUS PUTSCHKOWSKII* SKRJABIN, 1913, IN INDIA.[1]

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Up to the present, there have been only three records of the occurrence of representatives of the genus *Prosthogonimus* in India. Gideon (1929) recorded *Prymnoprion* sp. from the rectum of *Ibis megalocephala* in Darwar but Braun (1902) had already pointed out that the genus *Prymnoprion* is a synonym of *Prosthogonimus*. *P. indicus*, obtained from the oviduct of a fowl at Mukteswar, was described by Srivastava (1938). Lal (1939) recorded *P. cuneatus* from the bursa fabricii of *Acridotheres tristis*. Recently one of the writers (Gideon) obtained some specimens of this genus from the intestine and rectum of the Pond Heron, *Ardeola grayi*. Lately Witenberg and Eckman (1939) have published a very useful, critical paper on the classification of the genus *Prothogonimus*. In this paper, they have dealt with twenty-three species of the genus, and reduced them to only seven valid species. According to these authors, the only characters that are useful in distinguishing the different species of the genus are (1) the relative size of the suckers, (2) the extent of the uterine coils and (3) the shape and distension of the vitellaria; all other characters are dependant upon the age and state of contraction of the worms and are subject to individual variations. They have also published a key for use in distinguishing the seven valid species of the genus. Applying this key to the Indian forms, the specimens from *Ibis megalocephala*, *Ardeola grayi* and the domestic fowl can be rightly referred to the species *P. putschkowskii* Skrjabin, 1913. *P. indicus* is distinguished from *P. putschkowskii* only by the posterior extent of the cirrus sac but according to Witenberg and Eckman (1939) this character is variable. The validity of this statement can be judged by a study of the figures of this species published by Skrjabin and the joint authors. In the former, the cirrus sac extends up to the anterior border of the ventral sucker, while in the latter it terminates much in front of this organ. It is therefore quite evident that *P. indicus* Srivastava, 1937, is synonymous with *P. putschkowskii* Skrjabin, 1913 and that the forms from *Ibis megalocephala* and *Ardeola grayi* also belong to this species.

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[1] Paper read before the 28th session of the Indian Science Congress, Benares, held in January, 1941.

A few observations on the anatomy of these forms from *Ibis megalocephala* and *Ardeola grayi* are given below :—

The specimens from *Ibis megalocephala* are lanceolate and resemble that depicted in figure 1 of Witenberg & Eckman (1939), while the specimens from *Ardeola grayi* are broader, with a round posterior extremity, and are slightly attenuated anteriorly, resembling the specimen shown in figure 3 of Skrjabin (1913). They measure 4·695-7·396 mm. in length and 1·73-3·08 mm. in maximum breadth. The cuticle is spiny. The mouth is subterminal and is surrounded by the oral sucker which measures 0·249-0·365 mm. in diameter. The pre-pharynx is very small and measures 0·013-0·0152 mm. in length. The pharynx is globular and measures 0·16-0·238 mm. in diameter. The oesophagus is 0·173-0·479 mm. long. The intestinal caeca terminate 1·35-1·37 mm. from the posterior end of the body. The ventral sucker is situated at about the anterior fourth of the body and measures 0·81-0·84 mm. in diameter.

The excretory pore is situated at the posterior end of the body. The excretory bladder is Y-shaped, with a slightly sinuous and long stem, which bifurcates into two short arms at the level of the hinder border of the testes.

The genital pore is situated subterminally at the anterior end, on the left side of the oral sucker. The testes are oval or somewhat rounded bodies, situated slightly in front of the midbody. They measure 0·45-0·827 $\times$ 0·29-0·55 mm. and may be symmetrical or slightly oblique. The cirrus sac may be more or less sinuous and terminates some distance in front of the ventral sucker.

The ovary consists of about twelve to fifteen lobes and measures 0·4-0·85 $\times$ 0·27-0·7 mm. It lies slightly to the right of the middle line and its position with respect to the testes or the ventral sucker depends on the state of contraction of the worms. In the lanceolate form, it lies distinctly posterior to the ventral sucker and anterior to the zone of the testes, while, in slightly contracted and broader forms, it partially overlaps the ventral sucker and the testicular zone. The receptaculum seminis is pear-shaped, lies immediately behind the ovary and measure 0·25-0·275 $\times$ 0·135-0·17 mm. The vitellaria are lateral and consist of seven groups on the left side and eight or nine groups on the right side. Posteriorly they extend to a distance slightly short of the intestinal terminations but their anterior extent is variable. In the broader forms, they extend slightly in front of the zone of the ventral sucker, while in the lanceolate form they extend slightly anterior to the acetabular zone on the right side and on the left side they terminate in the middle of the acetabular zone. In the region of the intestinal caeca, the uterine coils are inter-caecal but, posterior to the terminations of the intestinal caeca, the uterine coils extend from one side of the body to the other. There is no special aggregation of the uterine coils in front of the ventral sucker. The eggs are operculate and measure 0·019-0·047 $\times$ 0·013-0·029 mm.

The material referred to in this paper has been deposited in the Zoological collection of the Indian Museum, Calcutta, as no. W3448-49/1.

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ON THE OCCURRENCE OF THE BAT FLUKE, *PROSTHODENDRIUM OVIMAGNOSUM* (BHALERAO, 1926) IN A DOG.[1]

By G. D. BHALERAO, *D.Sc., Ph.D. (Lond.), F.Z.S., F.R.M.S., F.A.Sc., Helminthologist,*

Imperial Veterinary Research Institute, Mukteswar-Kumaun, U. P., India.

Through the courtesy of Dr. P. A. Maplestone the writer had the opportunity of examining a few trematodes obtained by Mr. N. V. Bhaduri, B.Sc., M.B., from the intestine of a dog in Calcutta. On examination the flukes proved to be the species *Prosthodendrium ovimagnosum*, which the writer had described in 1926 from the bat, *Nyctinomus plicatus*, in Rangoon. In addition to the writer's original record of this parasite, it had been recorded by Northup (1928) from *Rhinopoma microphyllum* in Rangoon. The writer (Bhalerao, 1936) recorded it from *Nycticejus pallidus* in the Punjab. Dr. B. P. Pande, D.Sc., informed the writer that this species is also found in Allahabad. Outside India, Tubangui (1928) recorded it from *Scutophilus temminckii* in the Philippine Islands and Joyeux *et alia* (1937) from *S. borbonicus* in Northern Somaliland. It is thus evident that this parasite enjoys a very wide distribution in the orient and that it is normally a parasite of bats. The occurrence of this parasite in a dog is of considerable interest. It is quite possible that the dog may have acquired the infection by feeding upon an infected bat and acted only as a facultative host. Instances of this type are not uncommon. A few years ago the writer (Bhalerao, 1932) reported *Isoparorchis hypselobagri* from a man and a crocodile, although this is a normal parasite of the gas-bladder of the fish, *Wallago attu*, in India. Similarly the writer (Bhalerao, 1937) recorded *Paramphistomum cuonum* from the wild dog *Cuon dukhunensis*, although he suspected, from the degenerate nature of the material, that these amphistomes were not the normal parasites of dogs. Of similar nature is the infection of a wild cat by *Paramphistomum* sp. recorded by the writer (Bhalerao, 1937). A few observations on the anatomy of *Prosthodenrium ovimagnosum* from the dog in Calcutta are recorded below :—

The worms measure 0·435-0·6 mm. in length and 0·36-0·6 mm. in width. The cuticle is smooth. The following measurements refer to a specimen measuring 0·6×0·6 mm. The oral sucker is 0·106 mm. and the pharynx 0·048 mm. in diameter. The intestinal caeca terminate immediately in front of the testes. The ventral sucker is situated at 0·296 mm. from the anterior end and measures 0·083 mm. in diameter. The genital pore lies centrally, at 0·193 mm. behind the anterior end. The testes measure 0·155-0·168 mm. in diameter. The pseudo-cirrus sac measures 0·15 mm. in diameter. The ovary extends from one testis

[1] Paper read before the 28th session of the Indian Science Congress, Benares, held in January 1941.

to the other but occasionally it is slightly less extensive. There are 15-20 follicles of vitelline glands on each side. The uterine coils fill up the posterior half of the body. The largest egg measures 0·018 × 0·0135 mm.

The material referred to in this paper has been deposited in the Zoological collection of the Indian Museum, Calcutta, as no. W3447/1.

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INDIAN AND CEYLON SPONGES OF THE NATURHISTORISKA RIKSMUSEET, STOCKHOLM, COLLECTED BY K. FRISTEDT.

By H. SRINIVASA RAO, *M.A., D.Sc., Assistant Superintendent, Zoological Survey of India, Indian Museum, Calcutta.*

(Plates XII, XIII.)

The sponges on which the present report is based were collected by the late Dr. Konrad Fristedt in March and April 1889. At my request, Professor Dr. Sixten Bock of the Natural History Museum, Stockholm, was good enough to place the collection at my disposal for study and report as long ago as 1931. Owing to circumstances beyond my control the study of this collection was interrupted repeatedly, and it was not until early last year that I was able to give my undivided attention to it.

The sponge fauna of the Gulf of Manaar and its adjacent Indian and Ceylonese waters has been well known for many years now through the researches of Carter, Dendy, Kumar, Burton and Rao, and it is all the more surprising, therefore, to find 7 new species and 3 new varieties of sponges in the present small collection consisting of 42 species and 3 varieties representing 28 genera in all. No representatives of the orders Hexactinellida and Calcarea are present in the collection. Most of the collection is preserved in alcohol but a few are preserved dry.

I take this opportunity to offer my best thanks to Professor Dr. Sixten Bock of the Natural History Museum, Stockholm, not only for his courtesy and readiness in sending me the collection, but also for his kind indulgence in allowing me to keep the collection for over nine years.[1] I have also to thank Dr. Baini Prashad, Director, Zoological Survey of India, for facilities to study and report on this collection, and for readily agreeing to publish the present paper in the *Records of the Indian Museum* as suggested by Dr. Bock.

The photographs and drawings illustrating the present paper were executed under my supervision by Babus Subodh C. Mondul and R. Bagchi respectively, artists of the Zoological Survey of India, to whom my thanks are also due.

List of Indian and Ceylonese Sponges in the Fristedt Collection.

Order TETRAXONIDA.[2]

Sub-order *ASTROSCLEROPHORA.*

Fam. STELLETTIDAE.

1. *Stelletta purpurea* Ridley.
2. *Stelletta bocki*, sp. nov.

Fam. GEODIIDAE.

3. *Geodia inconspicua* (Bowerbank).

Fam. CHONDROSIIDAE.

4. *Chondrosia reniformis* Nardo.

Fam. TETILLIDAE.

5. *Chrotella australiensis* (Carter).

[1] Owing to the considerable risks involved at present in forwarding valuable manuscripts to neutral countries, Dr. Bock has very kindly accepted my suggestion to publish the present Report in India, although it was originally intended to be published in Sweden.

[2] I have followed the classification adopted by Burton (1937).

Fam. CLAVULIDAE.

6. *Pseudosuberites andrewsi* Kirkpatrick.
7. *Laxosuberities cruciatus* (Dendy).
8. *Suberites carnosus* (Johnston) Gray.
9. *Spirastrella inconstans* (Dendy).
10. *Spirastrella vagabunda* Ridley.
11. *Spirastrella purpurea* (Lamarck) Ridley.
12. *Cliona* sp.

Sub-order *SIGMATOSCLEROPHORA*.

Fam. HAPLOSCLERIDAE.

13. *Haliclona oculata* (Pallas).
14. *Adocia pumila* (Lendenfeld).
15. *Callyspongia diffusa* (Ridley).
16. *Callyspongia obtusispiculifera* (Dendy).
17. *Callyspongia cellaria*, sp. nov.
    Callyspongia cellaria var. *fusca*, nov.
18. *Callyspongia pambanensis*, sp. nov.
19. *Oceanapia fistulosa* (Bowerbank).
20. *Oceanapia arenosa*, sp. nov.

Fam. DESMACIDONIDAE.

Sec. *MYCALEAE*.

21. *Mycale indica* (Carter).
22. *Mycale aegagropila* (Johnston).
23. *Mycale monanchorata* Burton & Rao.
24. *Mycale trincomaliensis*, sp. nov.
25. *Biemna tubulata* (Dendy).

Sec. *MYXILLEAE*

26. *Strongylacidon stelliderma* (Carter).
27. *Iotrochota baculifera* Ridley.

Sec. *CLATHRIEAE*.

28. *Echinodictyum clathratum* Dendy.

Sec. *RASPELIEAE*.

29. *Prostylyssa foetida* (Dendy).
30. *Trachyopsis halichondroides* Dendy.

Order KERATOSA.

Sub-order *DICTYOCERATIDA*.

31. *Phyllospongia papyracea* (Esper).
32. *Spongia officinalis* Linn.
    S. officinalis var. *fenestrata*, nov.
    S. officinalis var. *bibulus*, nov.
33. *Hircinia fusca* Carter.
34. *Hircinia ramodigitata* Burton.
35. *Hircinia cactiformis*, sp. nov.
36. *Hircinia pellita*, sp. nov.
37. *Dysidea fragilis* (Montagu).
38. *Dysidea herbacea* (Keller).
39. *Luffariospongia clathrata* (Carter).
40. *Aplysinopsis reticulata* Hentschel.
41. *Spongionella tubulosa* Burton.

Sub-order *DENDROCERATIDA*.

42. *Hexadella purpurea* Burton.

Order TETRAXONIDA.

Sub-order *ASTROSCLEROPHORA*.

Family STELLETTIDAE.

Stelletta purpurea Ridley.

1884. *Stelletta purpurea* & var. *retroflexa*, Ridley, *Report Zool. Coll. " Alert "*, p. 473, pl. xl, fig. e, pl. xliii. figs. j-j*.
1926. *Stelletta purpurea*, Burton, *Ann. Mag. Nat. Hist.* (9) XVIII, pp. 44-49.
1932. *Stelletta purpurea* Burton & Rao, *Rec. Ind. Mus.* XXXIV, p. 310.

There are four lots of specimens in the collection three of which are from Pamban, South India, and one from Trincomalee on the east coast of Ceylon. The external form and other features of these sponges vary considerably, and it seems best to describe each lot separately to enable a comparison to be made.

The Trincomalee specimen (Stockholm Museum No. 656-H[1]) attached to a brown alga is roughly rectangular with straight and curved sides, 30×20 mm. The dorsal surface is convex and the ventral less so,

[1] The letters S. M. will be used to indicate the abbreviation for the words 'Stockholm Museum' in the rest of this paper.

purple above and paler below. The closely pitted upper surface is very rough with the pores not apparent. There is a single osculum 1·6 mm. in diameter on the edge of the straight side of the sponge. The sponge is hard and very little compressible. The smaller orthotriaenes and anatriaenes form a more distinct row below the sub-dermal spaces than in some of the Pamban specimens.

S. M. No. 668 from Pamban, S. India (2 fathoms) consists of three small irregularly oval or oblong sponges, 12×6 mm., $6\times4{\cdot}5$ mm., and 5×5 mm. in diameter. The first is attached, has a rough surface, minute pores and an oblong osculum ($1{\cdot}5\times0{\cdot}5$ mm.) with thickened lips, and the remaining two which are not attached have no oscula.

S. M. No. 682-A from Pamban is a cake-like concavo-convex form, with a roughly square outline and two short cornua-like processes resembling those of the hyoid apparatus of the frog and other vertebrates, 44×42 mm., 16-18 mm. thick, with the cornua 5-10 mm. high and 6-8 mm. thick. The sponge is apparently attached by its paler ventral surface to a substratum of calcareous nodules on which a few strands of algae are also found. The pores on the dorsal surface are not uniformly conspicuous. An oval osculum 2-3 mm. in diameter without a thickening of its outline is present at the angle opposite to which the bigger cornua arises. In the skeleton the oxea of the choanosome form a more or less confused reticulum of loose spicules.

S. M. No. 683-F from Pamban, S. India (3-5 fathoms) is a roughly spherical, pale to pale-yellow or dirty brown, firm but slightly compressible sponge, 26·5-40·0 mm. in diameter, attached by its basal surface to calcareous nodules. Groups of three or more conical prominences 2-4 mm. high and as broad at base are present on the sides. The surface is rough and full of minute pores. Two small oscula 1·0-1·5 mm. in diameter lead into a cavity or pit at the bottom of which is a small oblong opening. Spreading brushes of orthotriaenes (with a few anatriaenes) constitute a thin cortex enclosing oval spaces between the cones of the brushes which form subdermal cavities. A few of these spicules occur below the level of these cavities as well. Oxea are in irregular radial bundles, 1·0-1·4 mm. long, and 0·01-0·02 mm. thick; tylasters 0·018-0·022 mm. in diameter have few rays and do not occur in abundance.

Localities.—Pamban, Gulf of Manaar (S. M. Nos. 668, 682-A, 683-F); Trincomalee, Ceylon (S. M. No. 656-H).

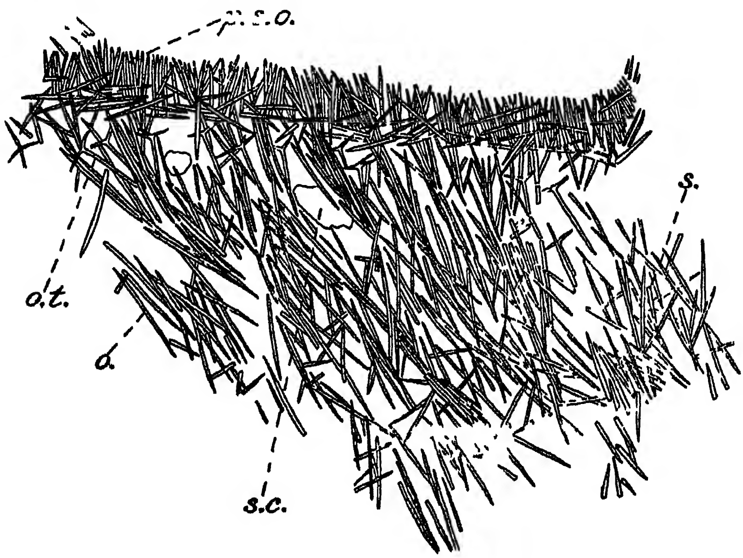
Stelletta bocki[1], sp. nov.

(Plate XII, fig. 15.)

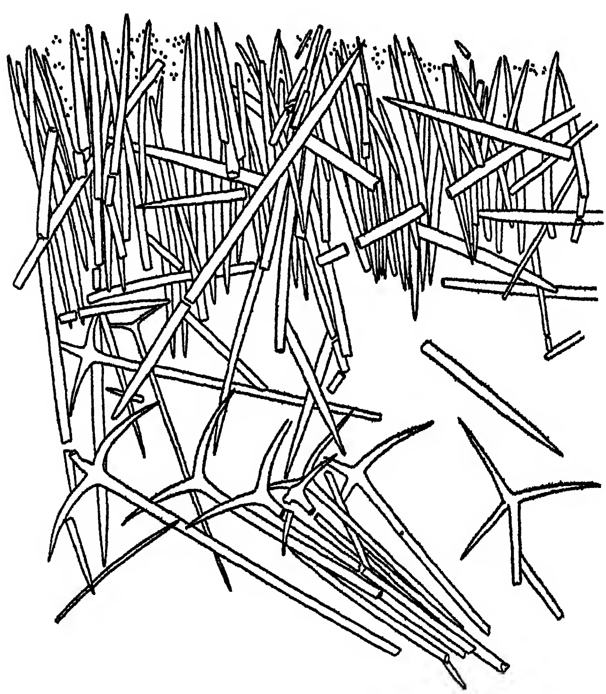
The sponge is a roughly oval, cake-like mass, 41 mm. long, 29·5 mm. broad, and 15·5 mm. thick, with a more or less plane ventral surface and a moderately convex dorsal surface, and with a thin cortex distinct from the underlying crumb-of-bread-like soft choanosome. It has a triangular compressed promontory from one side near the basal surface, and on the same side a prominent sinuous ridge near the dorsal surface.

[1] I have named this species after Prof. Dr. Sixten Bock of the Stockholm Museum through whose courtesy I was able to study the Fristedt collection of Indian and Ceylon sponges.

The sponge is firm and slightly compressible, smooth to the naked eye and slightly rough to the touch. The dorsal surface has numerous

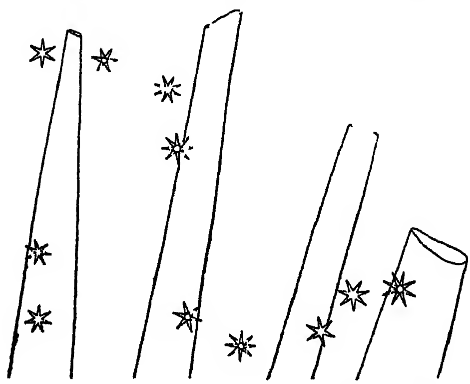


TEXT-FIG. 1.—Vertical section of cortex of *Stelletta bocki*, sp. nov. showing skeletal elements. *o.*, oxea; *o. t.*, orthotriaenes; *p. s. o.*, palisade of small oxea; *s.*, style; *s. c.*, sub-cortical space. × 26·6.



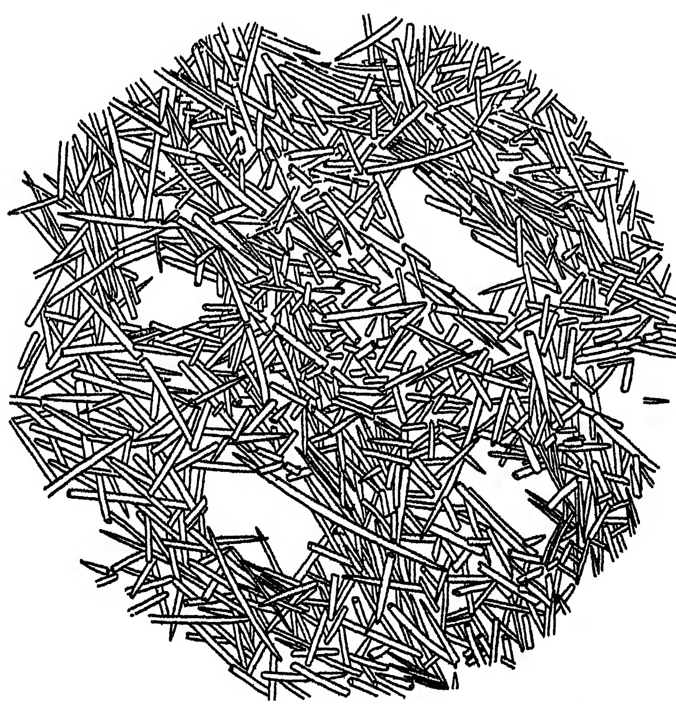
TEXT-FIG. 2.—Vertical section of cortex of *Stelletta bocki*, sp. nov. showing palisade of oxea, orthotriaenes, and the minute oxyspherasters. × 125.

minute closely-packed contracted pores (text-fig. 4) while the ventral has scattered cribriform pores and an arch-like row of about 20 oscula each 1·0 to 1·5 mm. in diameter (Pl. XII, fig. 15). The ventral surface and the sides are covered with a thin layer of sand particles while the dorsal surface is free from them. The colour of the sponge is pale brown



TEXT-FIG. 3.—Oxyspherasters of the cortical layer of *Stelletta bocki*, sp. nov. shown greatly enlarged, ×800.

to pink with the ventral surface distinctly of a lighter shade of brown. The choanosome is yellow and the cortex pink or pale brown. The skeleton is strikingly distinctive with its palisade of radially directed *small oxea*, not *microxea*, constituting a cortex, with a discontinuous

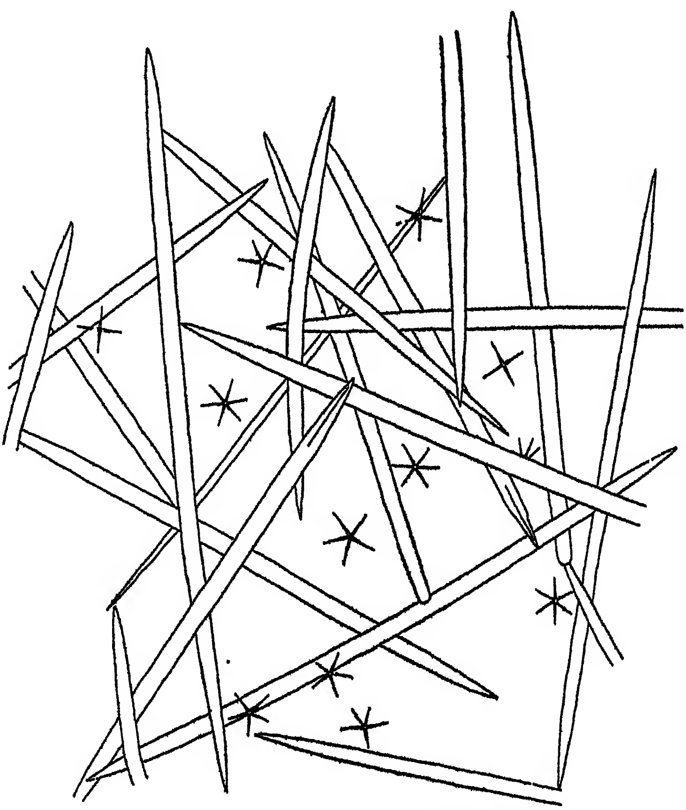


TEXT-FIG. 4.—Tangential section through cortex of *Stelletta bocki*, sp. nov. showing surface pores and skeleton. ×59.

single row of orthotriaenes below the palisade of oxea, and with radiating spicular fibres of a few moderately large oxea going up to the cortex. Loose oxea of large size and a few styles are scattered between the fibres, while oxyasters are confined to the choanosome only. In spicule preparations of the cortical portion very minute oxyspherasters with conspicuous centrum and short stout rays are occasionally found, but these are not abundant and may probably represent the developmental stages of the oxyasters (text-figs. 1-3 and 5).

Small oxea of the cortex 0·24-0·28 mm. long, straight or slightly curved; orthotriaenes 0·40-0·50 mm. long with cladi 0·060-0·080 mm. long; large oxea 0·50-0·60 × 0·02 mm., straight or curved and abruptly or gradually pointed; oxyasters with inconspicuous centrum, 0·032-0·048 mm. in diameter inclusive of the long, thin, pointed rays which never exceed 8 in number; and oxyspherasters 0·004 mm. in diameter.

The skeletal elements leave no doubt as to the genus to which the specimen should be assigned, but the curious palisade-like arrangement of the small oxea in the distinct cortex does not appear to have been described in any previously known *Stelletta*. The palisade-like cortical



TEXT-FIG. 5.—A portion of the choanosome of *Stelletta bocki*, sp. nov. showing oxea, styles, and oxyasters. ×170.

oxea recall strongly the arrangement of similar oxea in *Scolopes moseleyi* Sollas. *Scolopes* Schmidt is characterised by " a thin fibrous cortex

containing oxeas and microxeas radially arranged, palisade fashion. The megascleres are oxeas mostly collected into fibres, radially arranged. The microsclere when present is an amphiaster". It is clear that the present species has no generic relationship with *Scolopes* judging from the categories of skeletal elements present, and there is little justification for the erection of a new genus to receive the present species. The confusion that prevails in the grouping of genera assigned to families such as Epipolasidae, Donatiidae, Stellettidae and Jaspidae has been a deterrent on my inclination to refer the present species to a new genus. Students of sponges interested in discursive matter on these families may find the following references of some help: Topsent (1898 and 1900), Dendy (1916), Wilson (1925), Burton & Rao (1932) and de Laubenfels (1936).

Locality.—Trincomalee, Ceylon (8 fathoms), (S. M. No. 656-F)[1].

Family GEODIDAE.

Geodia inconspicua (Bowerbank).

1932. *Geodia inconspicua*, Burton & Rao, *op. cit.* p. 322.
1937. *Geodia areolata* and *Geodia picteti*, Burton, *Bull. Madras Govt. Mus.* (N. S.) *Nat. Hist. Sec.* 1, pp. 8-9, pl. 1, fig. 3.

An incomplete irregularly oval specimen 32·0 mm. long and 21·5 mm. broad is referrable to this species. The sponge was apparently growing on a small mass of calcareous nodules and shell-debris, fragments of which are still attached to it. The surface of the sponge is smooth in parts and rough in others. Conspicuous cribriform pores are confined to some parts of the sponge, while rounded pores 0·3-0·5 mm. in diameter are present in scattered groups on the basal part. The colour of the surface of the sponge is light brown, and of the soft crumb-of-bread-like inner mass pink. The texture is hard and very little compressible. The cortical layer of sterrasters is about a mm. thick. There are wide cylindrical conduits 1-2 mm. in diameter in the soft portion of the sponge which are lined by a transversely wrinkled membrane. The cortical layer of sterrasters is supported by the cladomes of the orthotriaenes and by the upper extremities of the larger oxea. A few anatrianes with thin rhabdomes penetrate the cortical layer with their cladomes projecting some distance above the surface. A few small oxea and small asters are scattered between the thin transparent dermal membrane and the layer of sterrasters. Where the membrane has peeled off, these skeletal elements have dropped out exposing the sterrastral layer. The oxyasters with small centrum and long thin rays are scattered in the choanosome singly or in groups. A few small oxea are also scattered in the choanosome immediately below the sterrastral layer in the interspaces between the large oxea and the rhabdomes of the triaenes.

Small Oxea 0·10-0·14 mm.×0·002-0·004 mm., large oxea 1·4-1·8 mm.×0·03, sterrasters 0·06-0·10 mm. in diameter, euasters 0·027-0·036

[1] The holotypes of all the new species and varieties described in the present paper will be deposited in the Naturhistoriska Riksmuseet, Stockholm, as soon as transport and other conditions in Europe are rendered safe, while a complete set of paratypes will be retained in the collection of the Zoological Survey of India, Indian Museum, Calcutta.

mm. in diameter, small euasters (probably developmental stages) 0·004-0·006 mm. in diameter.

Locality—Trincomalee, Ceylon (8 fathoms), (S. M. No. 657-B).

Family CHONDROSIIDAE.

Chondrosia reniformis Nardo

1932. *Chondrosia reniformis*, Burton & Rao, *op. cit.*, p. 321.
1937. *Chondrosia reniformis*, Burton, *op. cit.*, p. 10.

There are two lots of specimens in the collection which belong to this species. S. M. No. 683-B from Pamban is a flattened roughly rectangular piece 65 mm. long, 32 mm. broad, and 4-10 mm. thick, and has at its narrower end a conical process on one side 23·5×11·5 mm. It is hard and inflexible and is very like a piece of untanned hide, and the colour varies from a dark greyish brown to a pale muddy yellow or grey. Although smooth to the naked eye, the surface of the sponge is minutely pitted and bears very small scattered pores, and extensive whitish dendritic markings which seem to underlie the dermis. In addition to these there are areolae or cellular markings in the greyish portions which seem to be better developed than the dendritic ones. The surface of the sponge has also grooves and depressions. There are two elongated oscular openings 4 mm. in maximum diameter, one on the upper surface and the other on the periphery of the narrower side opposite the conical process. The under surface is rugged and the presence on it of sand particles in patches indicates that it was attached to some dead coral rock or shingle in shallow water. Of the two specimens from Trincomalee (S. M. No. 656-B) attached to filaments of brown algae, one is roughly rectangular in outline, 20 mm. in diameter and 5 mm. thick, and the other trapezoidal in outline, 23×18 mm. in dimensions and 2-4 mm. thick. Both are pink in colour and have the characteristic areolae formed by the coalescence of the dendritic markings. The single osculum, 1·5-2·0 mm. in diameter, is slightly raised above the rest of the surface. In both the lots pigment granules are found in great abundance arranged in groups of a few granules each, and below the dermis they are concentrated in a deeply coloured layer. No trace of the 'glary bodies' of Carter has been found.

Localities.—Pamban, Gulf of Manaar (S. M. No. 683-B); Trincomalee, Ceylon (S. M. No. 656-B).

Family TETILLIDAE.

Chrotella australiensis (Carter).

1934. *Cinachyra australiensis*, Burton, *Sci. Rep. Great Barrier Reef Exped. 1928-29*, IV, p. 523.
1937. *Chrotella australiensis*, Burton, *op. cit.*, p. 12.

Burton has fully discussed the synonymy of this species in the first reference cited. In the present collection this species is represented by a single incomplete roughly hemispherical specimen with probably only its basal part intact. It is 41·5 mm. long, 30·5 mm. broad, and has conspicuous porocalices 4·5-7·0 mm.×2·5-3·5 mm. The spicules do not as a rule, project much above the surface of the sponge, but

there is a certain degree of roughness due to the projecting broken ends of oxea. The spicular categories are typically arranged with a fair number of pro- and ana- triaenes and numerous microxea and sigmaspires. The microscleres seem to be somewhat roughened when examined under the high power of the microscope. The projecting megascleres are nearly all broken at their tip, but from their shape and size they seem to be mostly oxea. The pro-and ana- triaenes are found below the surface of the sponge so that many of them are complete. The microxea are generally disposed roughly at right angles to the megascleres.

Locality.—Pamban, Gulf of Manaar (3-5 fathoms), (S. M. No. 683-A).

Family CLAVULIDAE.

Pseudosuberites andrewsi Kirkpatrick.

1900. *Pseudosuberites andrewsi*, Kirkpatrick, *Proc. Zool. Soc. London*, p. 135, pl. xii, figs. 2*a*-*b*, pl. xiii, fig. 7.
1937. *Pseudosuberites andrewsi*, Burton, *op. cit.*, p. 14.

The species assigned to the genus *Pseudosuberites* are somewhat ill-defined in their features, and I, therefore, refer to this species with some hesitation a massive sepcimen 40×32 mm., and several small fragments which have been detached from this mass owing to its friability. The sponge is associated with coral, shell, and calcareous algal debris which are found in the substance of the sponge as well as at its base, and on some of which, at any rate, there are encrusting forms of what appear to be *Mycale*. The external form is difficult to describe owing to the occurrence of foreign particles which project in some parts above the surface of the sponge obscuring its general outline. Where the surface appears to be smooth to the naked eye it bears small flattened or cylindrical mamilliform processes 3-4 mm. high recalling those of *Pseudosuberites undulatus* (George & Wilson, 1919, pl. lvii, fig. 8) and of *P. hyalinus* Ridley & Dendy (Topsent, 1900, p. 171). The processes do not terminate in openings, but small pores about a mm. in diameter are scattered singly or in groups on various parts of the sponge. The canalicular markings in the ectosome of the type are not present in the specimen. The colour of the sponge varies from pink to purple or pale brown. The sponge is very soft and compressible in spite of the presence of embedded foreign particles, and the dermal membrane can be peeled off from the underlying choanosome. The sub-dermal spaces are inconspicuous and may be seen as narrow transverse streaks. The tylostyles are 0·2-0·3 mm. long and 0·0045-0·0075 mm. thick. The spicules of the dermal membrane form a reticulum or a pavement of spicules lying side by side. In parts of the choanosome the spicules form irregular fibres ascending to the surface of the sponge. Although the present specimen agrees with that recorded by Burton in spicular measurements, the external form, the sub-dermal canals, the dermal skeleton and the colour of the sponge differ considerably. Until the criteria of specific differences in the genus are more clearly defined, it will be undesirable to erect more new species. The size of the tylostyles seems to be a fairly reliable distinguishing feature between *P. andrewsi* and *P. hyalinus*.

Locality.—Trincomalee, Ceylon (8 fathoms), (S. M. No. 657-D).

Laxosuberites cruciatus (Dendy).

1905. *Suberites cruciatus*, Dendy, *Rep. Ceylon Pearl Oys. Fish.* Suppl. Rep XVIII, p. 131, pl. v, fig. 10.
1916. *Suberites cruciatus*, Dendy, *Rep. Govt. Baroda Mar. Zool. Okhamandal in Kattiawar*, Pt. ii, p. 135.
1921. *Suberites cruciatus* var. *depressa*, Dendy, *Trans. Linn. Soc. London*, (2) Zool. XVIII, p. 147.
1937. *Laxosuberites cruciatus*, Burton, *op. cit.*, p. 14, pl. viii. fig. 47.

There are two lots of specimens in the collection from different depths on the coast of Trincomalee. S. M. No. 659 from a depth of 12 fathoms consists of five fragments 15-35 mm. high. Each is part of a branching colony of short rounded or cylindrical processes not more than 15 mm. high, and 3-6 mm. in diameter. The whole colony has some resemblance to a Zoanthid colony in external form. A few irregularly scattered transparent spots on the surface of the sponge covered by a thin dermal layer of spicules may represent pore areas. There are one or two elongated shallow pits with small rounded apertures at their bottom on the sides of some of the processes, which probably represent oscula. The colour of the sponge in spirit is pale brown. The sponge is closely associated at its base with a colony of Hydroids which seems to have grown on it. One of the fragments is a growth on a small Purpurid or Mitrid Gastropod shell occupied by a hermit-crab and partly covered by a Polyzoan colony. S. M. No. 661 from 8 fathoms consists of fragments as in the other lot. There is a more profuse growth of Hydroids which are adherent to the surface of the sponge, and the processes which are longer (20 mm.) tend to be flabellate instead of cylindrical. The oscula are relatively large but irregular in outline. The skeleton agrees very well with the description given by Dendy and Burton. The tylostyles are in various stages of growth, the younger ones being thin and hair-like and less than 0·002 mm. thick. An average fully developed spicule is 0·3 mm. long and 0·006 mm. thick. The tylostyles resemble fairly closely those of *Suberites lobiceps* Schmidt (1870, p. 47, pl. v, fig. 5) and *S. epiphytum* (Lamarck) Ridley (1884, pl. xliii, fig. h). Had Schmidt's description been adequate the present species would have been designated *Laxosuberites lobiceps* (Schmidt). *S. epiphytum* and *S. cruciatus* var. *depressa* seem to be encrusting forms of the present species.

Locality.—Trincomalee, Ceylon (8-12 fathoms), (S. M. Nos. 659 and 661).

Suberites carnosus (Johnston) Gray.

1897. *Suberites carnosus*, Dendy, *Proc. Roy. Soc. Victoria* (N. S.) IX, p. 245.
1900. *Suberites carnosus*, Topsent, *Arch. Zool. Exper. Gen.* (3) VIII, p. 233, pl. vii, figs. 1-5.
1916. *Suberites carnosus* var. Dendy, *op. cit.*, p. 134.
1925. *Suberites carnosus*, Kumar, *Rec. Ind. Mus.* XXVII, p. 229.
1934. *Suberites carnosus*, Burton, *Ann. Mag. Nat. Hist.* (10) XIII, p. 314.

There are two lots of specimens from Pamban which belong to this species. S. M. No. 682-B consists of four fragments 37-50 mm. high and 24-40 mm. broad. Each of these consists of 2-4 stout club-shaped processes closely adherent by their sides to one another from one-third to three-fourths their height, and strongly recalling the shape of some forms of *Ficulina ficus*. The sponge is compact, soft and compressible,

and its colour varies from a light pink or brown to sandal-wood. The external surface of the sponge is minutely pilose or velvety when observed under a lens although smooth to the naked eye, and is often thrown into minute folds, elongate knobs or rugae. A few rounded pores not more than 1 mm. in diameter are found on the sides near the base of the club-shaped processes. Terminal or sub-terminal oscular openings, ellipsoidal, slit-like or triangular, and not more than a mm. in length or diameter, are present on the processes. The projecting ends of the tylostyles form several rows of oscular fringes. The presence of dead Gastropod shells at the base of some of the fragments of the sponge shows that it was growing on a bottom of shingle or shell-deposit. The ill-defined thin radiating spicular fibres end in fan-shaped surface brushes of tylostyles the extremities of which project above the surface of the sponge giving it the minutely pilose appearance described above. Below the brushes the tylostyles are scattered irregularly, sometimes in loose. bundles in various directions. The spicules are 0·4-0·6 mm.×0·006-0·008 mm. with their heads usually conical or top-shaped and with or without a constriction. In the younger spicules the conical shape of the head is more ponounced.

S. M. No. 683-C seems to represent a complete sponge growing on a base 26 mm.×10 mm. sticking to sand or calcareous matter. The sponge is 30 mm. high, 25 mm. broad and consists of 5-6 finger-shaped processes 15-18 mm. high and 4-7 mm. diameter. The texture is a little more firm than in the previous lot, and the surface relatively more rugose and pilose. No trace of oscula or pores is present. A large quantity of diatoms and desmids is entangled among the spicules of the surface brushes and the choanosome.

Locality.—Pamban, Gulf of Manaar (1-6 fathoms), (S. M. Nos. 682-B and 683-C).

Spirastrella inconstans (Dendy).

1887. *Suberites inconstans* and vars. *globosa*, *meandrina* and *digitata*, Dendy, *Ann. Mag. Nat. Hist.* (5) XX, pp. 154-157, pls. ix-x.
1934. *Spirastrella inconstans*, Burton, *op. cit.*, p. 570.

This species is represented in the collection by a dry specimen about 200 mm. high and 95 mm. broad which belongs to the var. *digitata* of Dendy. The individual digitate processes are 60-70 mm. high and 15-45 mm. in diameter. Some have at their extremity small or large oscular openings 4-12 mm. in diameter. Some processes are more or less solid with closely anastomosing spicular fibres, while others are hollow and chimney-shaped. There are several ramifying canals in the interior of the solid processes, while in the hollow processes they are very small and confined to the thickness of their walls. The inner surface of the chimney-shaped tube and of some of the larger ramifying canals is smooth. The base of the sponge is covered by calcareous nodules and particles of dead corals, algae, etc., while the upper parts are smooth. The colour of the sponge is a light brick-red. The tylostyles are 0·4-0·54 mm.×0·009-0·013 mm. There is considerable variation in the shape of the head of the megasclere which may be oval, elongate oval, hour-glass-shaped, or rounded. No microscleres were found in the preparations from various parts of the sponge.

This species corresponds to the tropi *tubulifera*, *digitata* and *concrescens* of *S. purpurea* of Vosmaer (1911), but it seems advisable to keep this species distinct from *S. purpurea* into which a great variety of closely allied forms has been merged.

Locality.—Trincomalee, Ceylon (1-3 fathoms), (S M. No. 268).

Spirastrella vagabunda Ridley.

1884. *Spirastrella vagabunda*, Ridley, *op. cit.*, p. 468, pl. xliii, figs. c, c'.
1921. *Spirastrella vagabunda*, Dendy, *op. cit.*, p. 139.

A single pale brown roughly angular or cylindrical fragment 40 mm. long 2·5-4·5 mm. in diameter belongs to this species. A few fragments of dead mollusc and barnacle shells, and of coral debris project from the surface of the sponge. No base of attachment, pores or oscula are discernible. The sponge has a smooth surface and a firm texture. Four or five canals pass vertically through the sponge. There is a cortex 0·2-0·4 mm. thick consisting of a close reticulation of tylostyles 0·22-0·54 mm.×0·02 mm. The spirasters of the surface layer are 0·018-0·027 mm. long.

Locality.—Trincomalee, Ceylon (10 fathoms), (S. M No. 666-A).

Spirastrella purpurea (Lamarck) Ridley.

1911. *Spirastrella purpurea*, Vosmaer, *Siboga Expeditie*, VIa[1], pp. 6-67, 14 pls.

The single specimen in the collection seems to agree with the trop. *pyramidalis* of Vosmaer both in the form of the skeleton and in colour and texture. The specimen is 25·0-27·5 mm. long, 7-14 mm. thick, roughly triangular and cushion-like in form, light purple in colour, and firm and compact in texture (*cf.* Vosmaer, 1911, pl. i, fig. 1). Its surface is uneven and studded with small abscess-like eminences. It was apparently found unattached, but a small hemispherical depression on one side in which the spicules are visible suggests the probability of its having grown over a small pebble. The surface of the sponge although smooth in appearance is somewhat rough to the touch. Except for a narrow elongate opening at one extremity which may represent the osculum, there are no pores or other openings on the surface. In section a few rounded canals may be seen in the periphery of the choanosome in addition to the thin dermal cortex of spinispirae. The tylostyles are 0·44-0·50 mm. long, 0·010-0·016 mm. thick with the diameter of the head 0·013-0·020 mm. The spinispirae are slender and long with 3-5 sharp bends in the course of their length, and with minute spines in a linear series or separated by short gaps and concentrated usually at the bends. The average spinispirae are 0·013-0·220 mm. long, and 0·002 mm. thick. A few rare stout ones in the choanosome are 0·018 mm. long and 0·004 mm. thick.

Locality.—Trincomalee, Ceylon (8 fathoms), (S. M. No. 656-G).

Cliona sp.[1]

A beach-worn shell of *Ostrea* bearing pit-like and canalicular excavations on the outer surface of the shell near the umbo was probably bored

[1] For an account of the Indian *Cliona* see Annandale, *Rec. Ind. Mus.* XI, pp. 1-24, pl. i (1915).

by a species of *Cliona*, but in the absence of spicules characteristic of the genus in the preparations made from scrapings of the excavations I am not at all certain that my identification is correct. I have seen in preparations only amphioxi and sigmata characteristic of Gelliine sponges, but these seem to be later growths in the excavations made by a *Cliona*. The evidence that the present specimen is a *Cliona*-bored shell is therefore presumptive.

Locality.—Trincomalee, Ceylon (1-5 fathoms), (S. M. No. 271).

Sub-order *SIGMATOSCLEROPHORA*.

Family HAPLOSCLERIDAE.

There is very little evidence in recent literature on the subject that the last word on the diagnostic features of the genera included in the family has yet been said, and that the differentiation of the genera is any simpler or easier now than it was at the beginning of the present century. The identification of specimens belonging to this family in the present collection has been attended with considerable difficulty, and I am not sure that I have reached the 95 per cent correctness which Burton (1934*b*, p. 528) claims for his method of identification by examining tangential sections of sponges of this family under three different magnifications. For example, there are specimens of Chalinine sponges in the present collection which from the general features of the skeleton and from the structure, texture, and colour of the sponges are assignable to *Haliclona*, but which, following Burton, should be assigned actually to *Adocia*. In a number of cases the problem of what constitutes a dermal skeleton as distinct from the underlying main skeletal fibres seems very difficult to solve. To save confusion to future workers it would seem to me to be a good plan for authors to support their identification with a good figure or photograph of the external form and the skeleton and with a short description of the main features of the sponge concerned. In the species assigned to this family in the present paper I have followed this plan subject to the limitations of space and cost of publication.

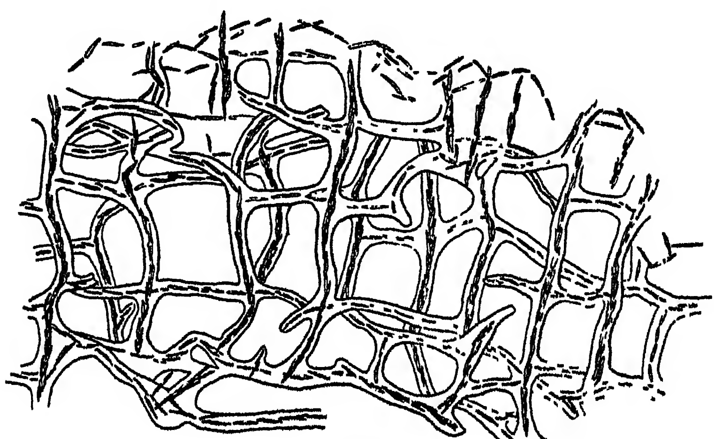
Burton (1934*b*, p. 539) has admirably clarified the position of the genera, *Haliclona*, *Adocia* and *Callyspongia* as "Haplosceridae with main skeleton a reticulation of spongin fibres cored with oxea; special dermal skeleton a network of similar fibres subdivided by secondary or even tertiary fibres. Microscleres toxa (and possibly sigmata)." The species described below as new to this family are so like *Callyspongia* in the general arrangement of the skeleton that I have no hesitation in ignoring the absence of toxa, and their replacement by sigmata as features characteristic of *Callyspongia*.

Haliclona oculata (Pallas).

1794. *Spongia oculata*, Esper, *Pflanzenthiere*, *Spongia* Tab. I, figs. 1-2.
1934. *Haliclona oculata*, Burton, *op. cit.*, p. 529.

There are two specimens in the collection, one preserved in spirit and the other dry, which may be referred to this species. S. M. No. 680 is an elongate, solid, rod-like sponge with anastomosing branches

5-10 mm. in diameter. It is of a pale golden-yellow colour and has a number of slightly elevated oscula 2-4 mm. in diameter arranged in a series on one side of the branches at a distance of 8-10 mm. between successive oscula. There is a definite surface tangential skeleton of thin transparent or pale spongin fibres cored by a row of single oxea. The polygonal meshes of the skeleton fibres are covered by a thin transparent membrane. The dermal spongin fibres arise from the tip of the main or radiating fibres at right angles to them. Although they are inconspicuous on account of the pale colour of the spongin, the disposition of the coring oxea indicates the occurrence of the dermal layer and the polygonal



a.

b.

TEXT FIG. 6.—Skeletal fibres of *Haliclona oculata*. *a*. Vertical section showing tangential and radial fibres. *b*. Tangential fibres viewed from surface of sponge.

meshes of the skeleton (text-fig. 6). The fibres of the dermal skeleton are 0·01-0·04 mm. in diameter and are, as a rule, unispicular. The main

ascending or radial fibres are multispicular, containing usually not more than two oxea, while the transverse secondary fibres are yellow, unispicular, and of the same diameter as the dermal fibres. Microscleres are absent. The meshes of the primary skeleton fibres are generally oblong, rectangular or square. Spicules are straight or curved, 0·08-0·09 mm. × 0·004-0·008 mm., many of which are broken into two or three pieces within the spongin envelope.

S. M. No. 262 is a dry incomplete specimen 155 mm. long and 76 mm. broad, with a number of closely anastomosing irregularly cylindrical branches 5-17 mm. in diameter, and several rounded oscula on small mound-shaped eminences which are more common on one side of the branches than on the other. No evidence of a base of attachment is present on the sponge. The skeleton fibres vary as in S. M. No. 680. Microscleres are absent. The fibres of the dermal tangential skeleton appear to be stouter (0·06 mm.) than those of the transverse secondary fibres (0·02-0·04 mm.) of the main skeleton, the spongin of the latter being of a paler yellow than that of the former. The radiating or ascending fibres are cored by bundles of 2-5 straight or curved oxea (0·09 × 0·004 mm.), while the dermal and the secondary fibres of the skeleton are cored by the same kind of oxea joined end to end or overlapping the adjacent oxea.

Localities. Pamban, Gulf of Manaar (3 fathoms), (S. M. No. 680); Trincomalee, Ceylon (3 fathoms), (S. M. No. 262).

Grant's *Haliclona occulata*[1] probably represents a Chalinine sponge as understood by later authors. The close resemblance of *H. oculata* (Pallas) to *Callyspongia ramosa* (Gray) has already been pointed out by Burton (1934*b*, p. 603), and unless the dermal skeleton is well-preserved it will be difficult to distinguish between the two species.

Adocia pumila (Lendenfeld).

1934. *Adocia pumila*, Burton, *op. cit.*, p. 537, pl. i, figs. 1-7.
1937. *Adocia pumila*, Burton, *op. cit.*, p. 20.

The species is well represented in this collection by a large number of branching and anastomosing fragments varying in colour from pale yellow to rusty brown. S. M. Nos. 686-B and 690 from Pamban are pale yellow to light brown, somewhat flattened, 10-15 mm. in diameter, and with oscula 3-5 mm. in diameter either slightly raised or on fistulous processes 8-10 mm. high and 6 mm. in diameter. S. M. No. 692 from Trincomalee is a small grayish brown sponge growing on the anterior end of a gastropod, 16 × 10 mm., with two elongate-ovate depressions or concavities (8·5 mm. long) at the base which give the specimen a compressed appearance. There is an osculum 2 mm. in diameter flush with the surface of the sponge at the broader end. S. M. No. 651 from Trincomalee consists of a large number of fragments of the colony, pale brown to rusty brown in colour. The branches are somewhat flattened with the outline of their cross-section irregular. Low conical tubercles less than 2 mm. high are present on the surface giving it a roughened appearance, but some parts of the sponge are smooth. Small fistulous

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[1] Grant, R. E., *Outlines of Comparative Anatomy*, p. 6, fig. 2 (London, 1841)

outgrowths 8-25 mm. high and 10 mm. in diameter arise from various parts of the sponge with a rounded or oval osculum at the extremity of each, but there are a few which attain a height up to 55 mm. Small barnacles are embedded in the sponge surface. Spongin is better developed in this lot than in the other two.

Oxea—0·14-0·15 mm. × 0·009-0·013 mm., sigmata 0·013-0·018 mm.

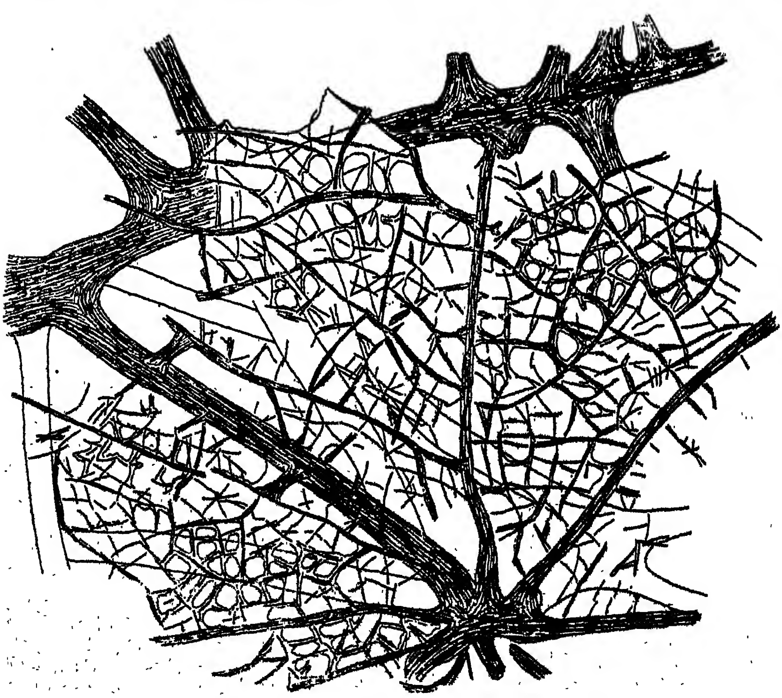
Localities.—Pamban, Gulf of Manaar (S. M. Nos. 686-B and 690); Trincomalee, Ceylon (S. M. Nos. 651 (½ fathom), and 692).

Callyspongia diffusa (Ridley).

(Plate XII, fig. 14.)

1881. *Tubulodigitus communis*, Carter, *Ann. Mag. Nat. Hist.* (5), VII, p. 367.
1889. *Siphonochalina communis*, Dendy & *Siphonochalina crassifibra*, Dendy, *Ann. Mag. Nat. Hist.* (6), III, pp. 81-82.
1890. *Siphonochalina procumbens*, Dendy, *Trans. Zool. Soc. London*, XII, p. 355.
Siphonochalina communis var. *tenuispiculata*, Dendy, *op. cit.*, p. 155, pl. vii, fig. 1.
1905. *Toxochalina robusta* var. *ridleyi*, Dendy, *op. cit.*, p. 140, pl. ix, fig. 2.
1916. *Siphonochalina crassifibra* and *S. minor*, Dendy, *op. cit.*, pp. 114-115.
1934. *Callyspongia diffusa*, Burton, *op. cit.*, p. 541.
1937. *Callyspongia diffusa*, Burton, *op. cit.*, p. 20.

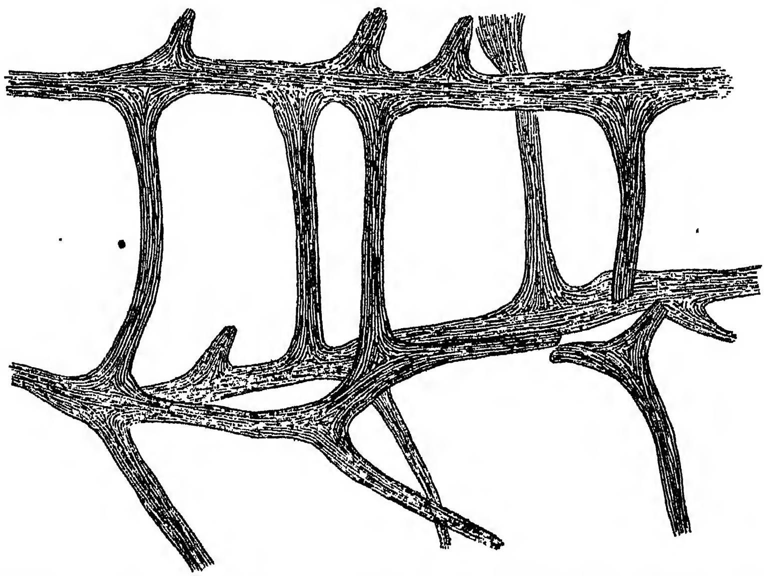
I refer to this species a flabellate, fan-shaped specimen from Pamban with low tubes and oscular openings along its margin. Its length is 83 mm. on its broadest side and 60-72 mm. on the narrower sides, and



TEXT-FIG. 7.—Dermal skeleton of a dry specimen of *Callyspongia diffusa*. × 48·6.

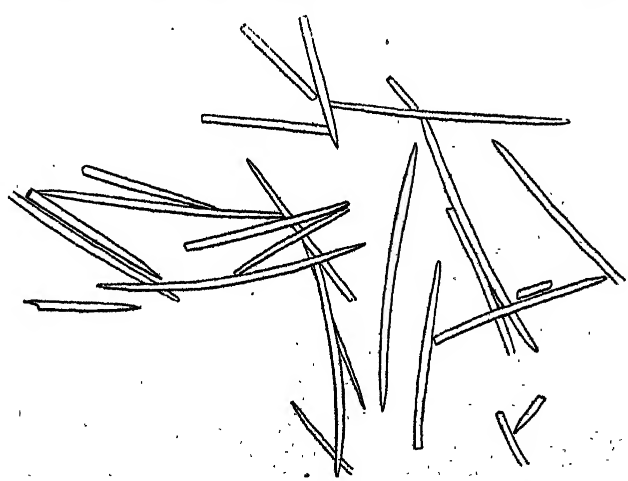
its thickness 4-8 mm. It was found on a colony of Polyzoa and Vermetid tubes and in between the valves of a young pearl oyster. On its upper

surface are four funnel-shaped processes 5-15 mm. high and 6-12 mm. in diameter, each with an osculum 2-5 mm. diameter at its extremity. On the longer arched side of the specimen are two irregular rows of slightly elevated oscular openings 1-5 mm. in diameter. The sponge is compressible and resilient, brown in the centre and somewhat paler on the periphery. The dermal and primary skeleton fibres are well develop-



TEXT-FIG. 8.—Primary fibres of a dry specimen of *Callyspongia diffusa.* ×44.

ed with the spongin yellowish brown in the latter and pale yellow in the former. A form of toxa not unlike that found in *Toxochalina robusta*



TEXT-FIG. 9.—Sharp and abruptly pointed oxea of a dry specimen of *Callyspongia diffusa.* ×340.

var. *ridleyi* Dendy, 0·0135-0·0225 mm. long is scattered along the fibres. The oxea, 0·072×0·004 mm., are in bundles of four or more, and do not

fill the spongin fibres of the main skeleton. In secondary fibres they are found singly or in twos (text-fig. 10).

A flat specimen from Trincomalee, 102 mm. long, 51-84 mm. wide, and 18-25 mm. thick attached by a base 15-20 mm. in diameter to a nullipore, and having four large, more or less contiguous, bulbous processes projecting above the surface of the sponge, is also to be referred to this species. The processes are narrow at base (15·25 mm. diameter) and broad distally (24-50 mm. diameter). What appear to be pores are the openings of hollows in which small barnacles are lodged. Oscula 3·15 mm. in diameter occur in pairs on the distal end of the processes. The dermal sub-reticulum of small fibres is often obliterated, but usually present on the underside of the sponge (text-figs. 7-8). The colour of the sponge is a light dirty brown. The character and arrangement of the skeleton fibres are as in *C. obtusispiculifera* (S. M No. 263),

TEXT-FIG. 10.—Skeletal fibres of a specimen of *Callyspongia diffusa*. *a.* Portion of the primary skeleton. *b.* A single mesh of the primary skeleton enlarged to show the arrangement of the spicules.

but the spicules are generally oxea with sharp and abruptly pointed ends, the dimensions, colour and character being as in that species (text-fig.

9). Except in the external form, the mode of branching, and the nature of the spicules, the two specimens assigned to this species seem to be very closely allied, if not identical. In fact, the subtlety of points of difference between species assigned to the genus *Callyspongia* should serve as an indication that a too rigid system of classification has its pit-falls.

Localities. Pamban, Gulf of Manaar (3 fathoms), (S. M. No. 681-B); Trincomalee, Ceylon (1-3 fathoms), (S. M. No. 265). Dry.

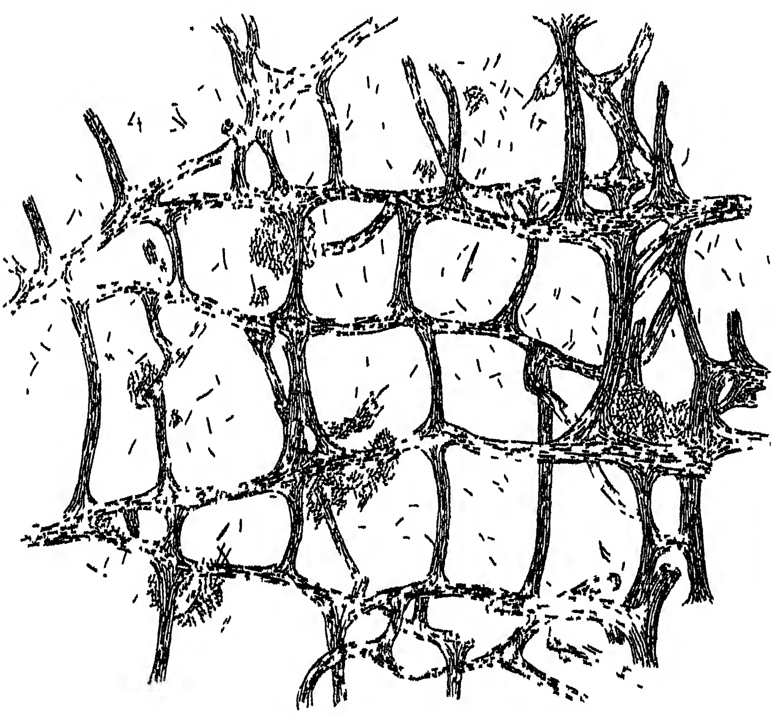
The second specimen has also a close resemblance to *Ceraochalina implexa* Topsent (1892, *Mem. Soc. Zool. France* V, p. 27, pl. i, fig. 6) from the Red Sea.

Callyspongia obtusispiculifera (Dendy).

(Plate XII, fig. 13.)

1905. *Chalina obtusispiculifera*, Dendy, *op. cit.*, p. 150, pl. x, fig. 9.

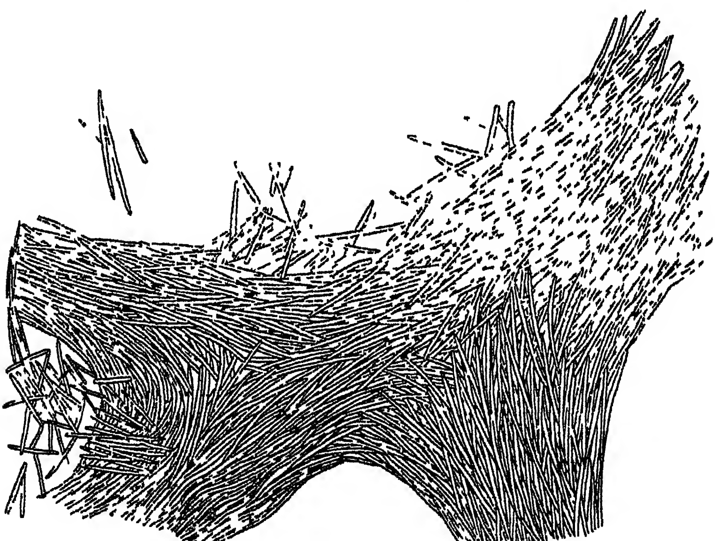
A bushy colony (of closely branching and anastomosing, vertically disposed, digitate processes) 117 mm. broad, 122 mm. high, and 78 95 mm. thick seems to belong to this species. Dendy has not figured the external form of the sponge. The processes are 10-75 mm. high and



TEXT-FIG. 11.—Primary skeleton of *Callyspongia obtusispiculifera* showing the regular meshes. ×26·6.

4-16 mm. in diameter, and rise unequally one above the other like the trees in a forest. They may be cylindrical, angulate or flattened, and

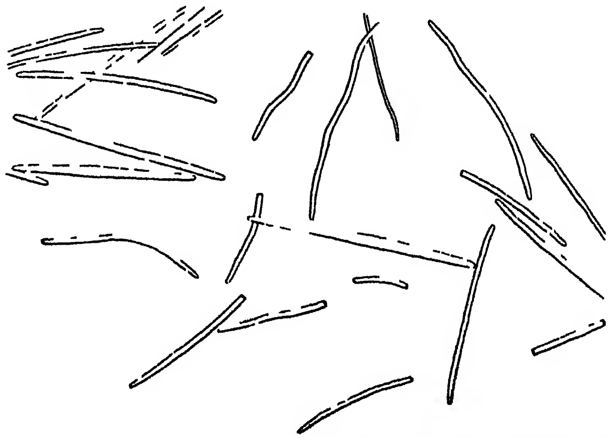
disposed at various angles to one another. On the base of the colony there is a roughly rounded hollow 40 mm. in diameter and 50 mm. in depth which had presumably lodged in life a piece of coral, nullipore nodule, or stone around which the colony started growing. Except for a few fragments of a barnacle sticking to the fibres on the outer fringe of the mouth of this hollow, the sponge bears no trace of the substratum on which it was found. There are no pores on the surface of the sponge apart from the polygonal openings of the cribriform dermal membrane which has been damaged at many points. Oscula 2-4 mm. in diameter are present at the free extremity of most of the digitate processes and rarely on the sides below it. The skeleton consists of an anastomosis of stout spicular fibres (0·06-0·10 mm. in diameter) in more or less regular patterns, chiefly a triangle or a rectangle. The primary fibres at the surface have a polygonal sub-reticulation of smaller fibres (0·02-0·04 mm. in diameter) in the interspaces between the larger fibres. The arrangement of the primary fibres is very regular and consequently the fibres rise one above the other as in a scaffold or ladder (text-fig. 11) At the surface of the sponge the primary fibres appear as prominent ridges, and the junction of two or more fibres is raised into a knob. There



TEXT-FIG. 12.—A junction of the primary fibres of *Callyspongia obtusispiculifera.* × 220.

is thus no distinct dermal membrane which can be peeled off from the surface of the sponge, but it is constituted by the anastomosis of the smaller branching fibres arising from the primary fibres. Spicules are strongyles, or rarely, slightly centrotylote strongyles, straight, flexuous or vermiform, 0·07-0·09 mm. × 0·002-0·004 mm., and of a pale pink colour (text-fig. 13). The spicules are closely packed together in the centre of the fibre, often leaving clear spongin of a thickness of about 0·009 mm. on the periphery of the fibre. Where the fibres join or branch off the junctions are broad, triangular, diamond-shaped, or rectangular (text-fig. 12). No microscleres are present. The colour of the sponge

in its dry state is dirty grey, and the texture brittle. The surface of the sponge in its living or fresh state was probably smooth as the absence of projections, aculeations or knobs on the dry sponge indicates.



TEXT-FIG. 13.—Vermiform, straight, or curved centrotylote strongyles of *Callyspongia obtusispiculifera.* ×340.

Locality.—Trincomalee, Ceylon (1-3 fathoms), (S. M. No. 263).

Although the present specimen does not agree fully with Dendy's description of the species, I prefer to place it here with a full description of it to calling it a new variety or new species with close affinities to Dendy's species. The close relationship of this species to *Callyspongia diffusa* is undoubted, and I should have no hesitation in referring it to this species but for the form of the spicules.

Callyspongia cellaria, sp. nov.

(Plate XII, figs. 1-7.)

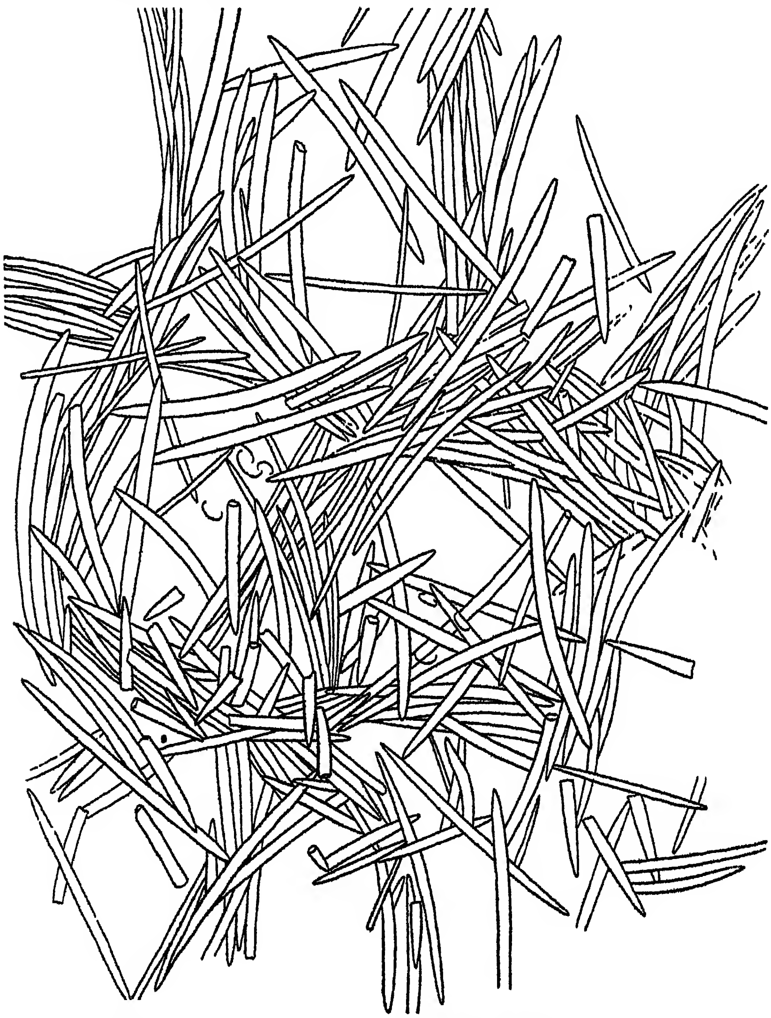
There are two lots of specimens in the collection, one from Pamban and the other from Trincomalee, which I am unable to match with any known species of *Callyspongia*.

S. M. No. 658 from Trincomalee consists of four fragments. One is femuroid in shape, 75 mm. long, 15-20 mm. in diameter where it is flat, and 22·5 to 35·0 mm. where it is convex, a second one 55 mm. × 20-25 mm. of a somewhat similar shape, a third 45·0 × 27·5 mm., irregularly ovoid or oblong and found attached to the valve of a dead Pelecypod shell, and lastly a compressed specimen with a roughly hastate outline 46·0 mm. long and 22·0-29·0 mm. in diameter on the convex portion and 14·0 mm. in diameter on the flat portion. The colour of the fragments in spirit is a dirty yellowish brown.

S. M. No. 689 from Pamban is a small bun-like specimen 38-48 mm. in diameter and 29 mm. in height attached to the valve of a dead Spondylid Lamellibranch mollusc and other shell-debris. The colour of the sponge in spirit is a pale yellowish brown.

The most characteristic features of the species are the presence of well developed spongin forming in conjunction with oxeote spicules *broad band-shaped or lamellar spicular fibres and the extremely fenestrated*

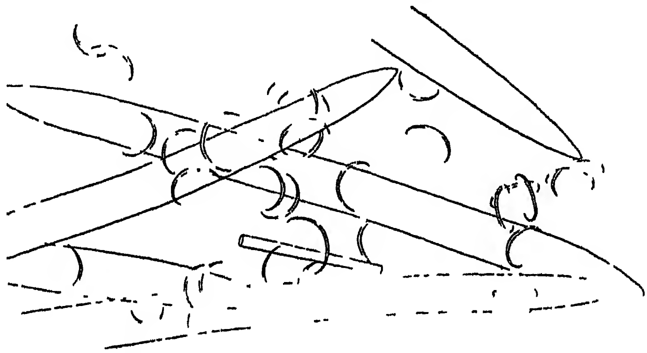
and cellular appearance of the surface and interior of the sponge. The general external appearance of the sponges belonging to the species is thus that of a honey-comb. The texture is firm and very little compressible. The pores, more numerous on the upper surface, are extremely variable in shape and size (0·5-1·5 mm. diameter) and freely coalesce with the adjacent ones, and the oscula (3·5 mm. in diameter) are scattered on the sides and upper surface of the sponge. The skeleton consists



TEXT-FIG. 14.—Skeletal fibres near surface of *Callyspongiae ellaria*, sp. nov. ×166·6.

of an irregular reticulation of loose spicules or spicular fibres of one or more oxea, straight or curved, forming a rough isodictyum with no special dermal layer of spicules except in parts of the sponge very little exposed to the abrasive action of foreign particles, where small vertical bundles of oxea form a pilose covering (text-fig. 14). Loose spicules are often scattered in the meshes of the reticulum. The oxea are 0·16-0·24 mm. long and 0·0022-0·0135 mm. thick, and gradually or abruptly

narrowed at the extremities. Many thin hair-like oxea, which presumably represent the growth stages of the same category of spicules, are also present. The crescent-shaped sigmata, 0·018-0·027 mm. chord,



TEXT-FIG. 15.—Spicules of *Callyspongia cellaria*, sp. nov. ×406·6.

are quite abundant on the surface dermal membrane where preserved and in the interspaces between spicules (text-fig. 15). They are more common where spongin is present. Particles of calcareous debris are commonly sticking to the surface skeletal fibres, and filaments of brown algae are often found sticking out of the lumen of the oscula.

Localities. Trincomalee, Ceylon (8-10 fathoms), (S. M. No. 689).

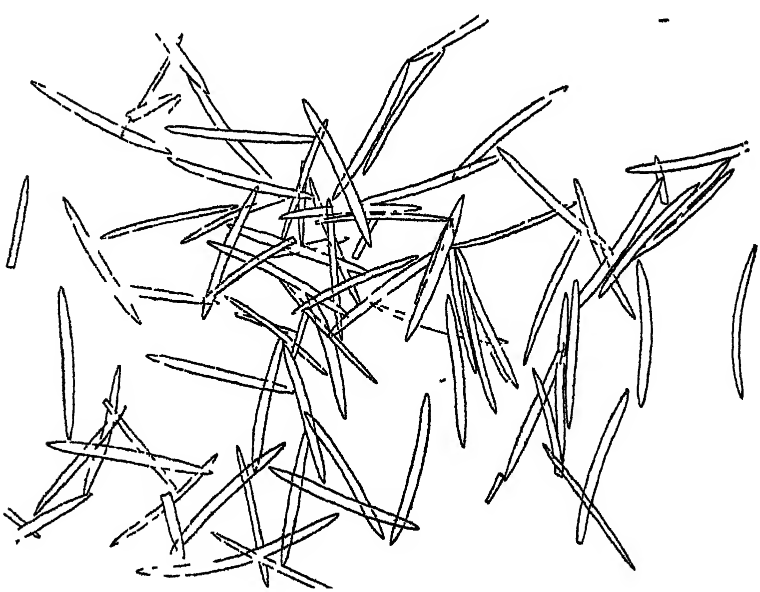
Callyspongia cellaria var. **fusca**, nov.

(Plate XII, figs. 8 and 9.)

This sponge differs from the one described above chiefly in colour and texture and in the dimensions of the spicular elements. The specimens are somewhat incomplete and include two fragments. Of the fragments, one is 54·0 mm. long, 24 mm. broad, and 11-13 mm. thick, and the other, a short club-shaped specimen, 35·5 mm long, 15·5 mm. broad at the tip and 9·5 mm. broad at base. Of the incomplete specimens one is in the form of a pair of clubs joined together a little above the base. It is 118 mm. long, 22·0 mm. to 41·0 mm. broad at the club-shaped extremities, 13·5-23·5 mm. in diameter below the club-shaped part, and 33·5 mm. in diameter where the two clubs are joined together. The other specimen is transversely elongate, hoof-shaped, 97·5 mm. broad, 40-50 mm. high, and has a few short mound-shaped projections 10-15 mm. high from the upper surface. In life it was apparently attached to a dead coral or other calcareous debris at three separate points where fragments of calcareous matter are embedded in the substance of the sponge. All the specimens have numerous oscula 5-8 mm. in diameter, usually flush with the surface of the sponge but sometimes with a slightly tumid lip. A dermal reticulation of spicular fibres formed of one or more spicules is apparently present all over the sponge, but in the state in which it is preserved it is found only in depressions of the sponge surface where it has not suffered damage by abrasive foreign debris. The spicular fibres are relatively thin and form a circular or polygonal reticulation. In the meshes of the spicular fibres a sub-

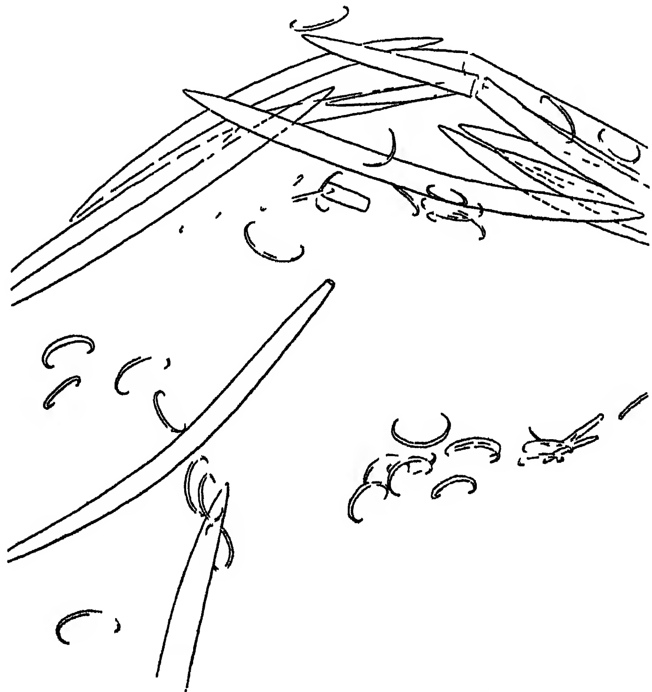
isodictyal skeleton of a few spicules may be formed (text-fig. 16). The oxea are straight or curved with the extremities abruptly narrowed,

TEXT-FIG. 16.—Skeletal fibres of *Callyspongia cellaria* var. *fusca*, nov. below the dermis with a few sigmata in the centre ×49·3.



TEXT-FIG. 17.—Oxea of *Callyspongia celluria* var. *fusca*, nov ×125.

0·15-0·23 mm. long, and 0·013-0·014 mm. in diameter. The sigmata, 0·0135-0·018 mm. chord, are thin and confined to the dermal skeleton



TEXT-FIG. 18.—Oxea and sigmata of *Callyspongia cellaria* var *fusca*, nov. ×560.

(text-figs. 17 and 18). The sponge is dark brown in colour, less firm and relatively more resilient than the specimens of *Callyspongia cellaria*.

Locality.—Pamban, Gulf of Manaar (3 fathoms), (S. M. No. 686-A).

Callyspongia pambanensis, sp nov.

(Plate XII, figs. 10-12.)

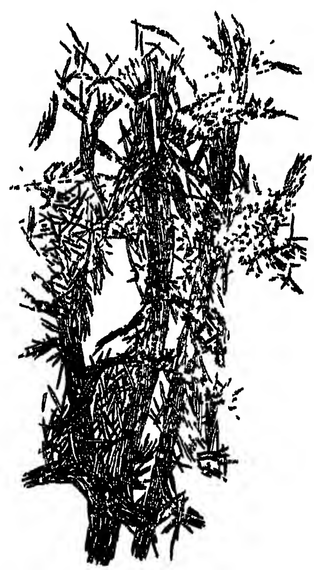
Form digitate or flabellate, slightly branching and anastomosing, texture resilient, furry external surface, and the colour light brown. Pores and oscula numerous. Main skeleton consisting of more or less parallel ascending spicular fibres arching towards the distal end and the periphery of the sponge and connected by short thin transverse fibres. The brush-like termini of individual fibres anastomose with similar adjacent termini to form a dermal membrane, with a small bunch of short spicular fibres projecting at the junction of the main and dermal fibres. It is the projecting fibres which give the sponge surface its furry appearance.

Several stout finger-shaped fragments are present in the collection One of them is 74·5 mm. long, 25-31 mm. broad, and 14·5-15·5 mm. thick. Another, which is somewhat flabellate, is 51·0 mm. broad, 51·0 mm. high, and 10-20 mm. thick. The pores are less than 1 mm. in diameter, and

the oscula, which may be flush with the surface of the sponge or elevated on mounds, are rounded, oval, or stellar in outline. The oscula are 3-7 mm. in diameter and lead into chambers at the bottom of which are

TEXT-FIG. 19.—Surface fibres of the skeleton of *Callyspongia pambanensis*, sp. nov. ×21·6.

several smaller openings. The primary spicular fibres are 0·12-0·20 mm. in diameter. The surface brushes of spicular fibres are 0·40-0·60



TEXT-FIG. 20.—Radiating fibres of the skeleton of *Callyspongia pambanensis*, sp. nov. ×21·6.

mm. high and 0·08-0·10 mm. in diameter (text-figs. 19 and 20). The oxea are usually sharply and abruptly ended, but a few have gradually

narrowing extremities (text-fig. 21). Occasional styles and strongyles may occur. The oxea are 0·18-0·26 mm. long and 0·004-0·018 mm.

TEXT-FIG. 21.—Oxea of *Callyspongia pambanensis*, sp. nov. ×83·3.

in diameter. No sigmata or other microscleres present. The spongin is less developed than in *C. cellaria*.

Locality. Pamban, Gulf of Manaar (3 fathoms). (S. M. No. 688).

Oceanapia fistulosa (Bowerbank).

1905. *Phloeodictyon fistulosum*, Dendy, *op. cit.*, p. 165.

This species is represented in the collection by a single incomplete fistula 72·5 mm high, 10·5-16·5 mm. in diameter, tapering to a narrow cone (above the narrowest part of the cylindrical portion) 25 mm. high. The thickness of the rind varies from 2·0 to 2·5 mm. At the distal extremity of the cylindrical portion is a large transverse osculum shaped like a printer's roller with handles, *i.e.*, with a circular outline in the middle and oblong at the ends. A few smaller oscula, oval or oblong in outline occur scattered over the rest of the fistula. The conical part of the fistula ends blindly and is without an osculum. The numerous pores are found closely packed together all over the fistula. The dermal skeleton consists of a loose reticulum of spicular fibres with two or more spicules while the deeper main or primary skeleton is formed of a relatively larger number of spicules. The primary fibres are at right angles to the dermal skeleton at various points and their extremities project on the surface giving the sponge its roughness. Oxea 0·26-0·48 mm. / 0·006-0·009 mm. Very little spongin is present.

Locality. Pamban, Gulf of Manaar (S. M. No. 683-D).

The sandy tubes of a Polychaete worm are found adhering to the sides of the fistulum.

Oceanapia arenosa, sp. nov.

(Plate XII, figs. 16-18.)

A fistulum, 27 mm. long, 8 mm. in diameter, with an osculum 2 mm. in diameter, which presumably represents only a part of the sponge does

not agree with the description of any hitherto known species of *Oceanapia*. The specimen is sharply geniculate near the base where the diameter of the fistulum is reduced by nearly half. It is firm though compressible, slightly rough on the surface, and pale yellowish in colour. Numerous pores 0·3-0·5 mm. in diameter are present on the surface of the sponge. The sponge is covered by a thin transparent dermal membrane supported by a few tangentially disposed oxea forming a loose reticulum, or by uni- or multispicular fibres (0·01-0·04 mm. thick) which anastomose, and give rise to the porous appearance of the sponge surface. The naked-eye appearance of the sponge is, however, smooth. Underlying the

TEXT-FIG. 22.—Skeletal fibres of *Oceanapia arenosa*, sp. nov. *a*. Deeper fibres; *b*. surface fibres.

membrane and the surface fibres are the stouter primary spicular fibres 0·06-0·12 mm. thick. The lumen of the fistulum is lined by a closely agglutinated layer of fine sand and other foreign particles which form a mosaic from the base to the extremity of the fistulum. This mosaic is, however, overlaid by a thin transparent membrane which can be peeled off the layer of sand particles. The spicular fibres consist of gently curved, sharply pointed oxea (0·16-0·18 mm. × 0·0045-0·0060 mm.) which taper gradually from the middle of the spicule to the end. The spicules of the primary skeleton are generally stouter than those of the dermal skeleton, but do not, on that account, form a distinct category of skeletal element. No microscleres are present (text-fig. 22).

The sponge is closely associated with a colony of Zoanthids the surface of which is coated with sand particles, and it is difficult to say whether a bulb-like or root-like main body of the sponge was present or not buried in sand.

The spiculation is characteristic of the genus *Oceanapia*, but in all other features the species seems to differ from previously described forms. The narrow lumen of the fistulum lined by an agglutination of sand particles, the occurrence of a lining membrane over the mosaic of sand

particles, and the presence of a thick cortex distinguish this species from the other known species of the genus.

Locality. -Pamban, Gulf of Manaar (1-5 fathoms), (S. M. No 671).

Family Desmacidonidae.

Section *MYCALEAE.*

Mycale indica (Carter).

1889. *Esperia indica*, Carter, *Journ. Linn. Soc. London*, XXI, pp. 72-73, pl. vi, figs. 3-6

1932. *Mycale indica*, Burton & Rao, *op. cit.*, pp. 327-328.

Three massive specimens, of which one is dry and the other two preserved in alcohol, belong to this species. S. M. Nos. 683-E and 687 from Pamban are incomplete and are very much alike in form and consistency. The dry specimen, S. M. No. 261 from Trincomalee, is extremely fragile although it has at present a more or less oval form. The larger of the two specimens preserved in alcohol is 120 mm. broad, 70 mm. thick with finger-like processes 10-15 mm. long on the upper surface, while the other, 48 mm. broad and 18 mm. thick, has no digitate processes. The range of colour in preservation is light yellow to pale. Foreign matter, such as dead shells, corals, etc., is imbedded in the substance of the sponge in both the specimens. No pores or oscula are evident, but invaginations of the sponge surface in some parts give it a cavernous form. The sponges are slightly compressible though fragile. The naked-eye view of the surface of the sponge is smooth, but under a hand lens the dermal layer of tangential styles which forms a cortex 1 mm. thick shows it to be minutely roughened. The primary skeleton consists of a reticulum of spicular fibres which, radiating fan-wise towards the dermal spicular layer, seems to support it. The categories of spicules are styles 0·44-0·66 mm. × 0·0135 mm., large anisochelae 0·112-0·135 mm., small anisochelae 0·0135-0·0270 mm., small and large C- and S-shaped or contort sigmata 0·0135-0·0180 mm. and 0·045 mm. chord respectively, and trichodragmata 0·0225-0·0450 mm. The large anisochelae seem to echinate the spicular fibres at many points. S. M. No. 264 is 130 mm. broad, 65 mm. thick, and resembles S. M. No. 687 from Pamban. Its spiculation is very similar except in the anisochelae being relatively fewer.

Localities. - Pamban, Gulf of Manaar (1-5 fathoms), (S. M. Nos. 683-E, 687); Trincomalee, Ceylon (1-5 fathoms), (S. M. No. 264).

Mycale aegagropila (Johnston).

1898. *Esperella aegagropila*, Vosmaer & Pekelharing, *Verhand. Kon. Akad. Wetensch. Amsterdam* VI (2), pp. 19-31, pls. i-iii.

1911. *Mycale macilenta* var. *australis*, Hentschel, *Die Faun. Südwest Austral. Tetraxonida* III, pp. 296-297, text-fig. 6.

1925. *Mycale aegagropila*, Wilson, *Bull. U. S. Nat. Mus.* II, Bull. 100, p. 426.

To this species I refer a few small fragments of an incrustation which invests the zooids of a branching colony of Alcyonaria, white in colour. It agrees in many respects, including size of spicule categories, with the description of the Philippine specimens in the last reference cited

above. The sponge forms a thin diaphanous or lace-like investment less than a millimetre thick over the zooids. The dermal tangential skeleton consists of a reticulum of spicular fibres with only a few subtylostyles. The microscleres are also scanty. Bundles of subtylostyles project here and there from the surface of the sponge. The occurrence of two sizes of anisochelae and of slender hair-like subtylostyles may prove to be distinctive characters justifying the recognition of a new variety, if not of a new species, but in view of the fact that distinctions based on measurements of spicule categories, some of which wholly drop out, have been carried too far towards a state of nomenclatorial confusion I refrain from burdening the literature on the subject. The hair-like subtylostyles are undoubtedly stages in the growth of the spicules of this category. In his report on the Philippine sponges Wilson (1925) mentions young stages of anisochelae 0·004 mm. long. The problem of distinguishing various growth stages of a single category of spicules from the different sizes occurring in spicule categories of a given kind is far from being solved. Until extensive biometrical studies of sponges come into vogue the problem will remain unsolved resulting in needless confusion in taxonomic studies.[1]

Measurements of spicules.

Subtylostyles (needle-shaped)	0·20-0·26 mm.
Slender hair-like subtylostyles	0·22 mm.
Large anisochelae in rosettes	0·036-0·045 mm.
Small anisochelae (loose)	0·013-0·023 mm.
Sigmata (C- and S-shaped)	0·05-0·09 mm. (chord).
Toxa (few)	0·07-0·18 mm. rarely 0·24 mm.

Locality.—Pamban, Gulf of Manaar (1 fathom), (S. M. No. 669-B).

Mycale monanchorata Burton and Rao.

1932. *Mycale monanchorata*, Burton & Rao, *op. cit.*, p. 329.

This species is represented by four small, more or less rounded, pale brown, soft and compressible masses 20-30 mm. in diameter and 20 mm. in height, with the terminal parts of the radiating fibres projecting on the sponge surface as white hairy prolongations. The sponge is somewhat cavernous and bears no trace of a dermal skeleton or membrane or of a base of attachment to the substratum unless the dark brown patch on the lower surface of the sponge represents it. The spicular fibres (0·06-0·20 mm. in diameter) branch and anastomose to form a net-work with spongin well developed in the thicker fibres. In addition to the characteristic needle-shaped subtylostyles which occur in the fibres and in the choanosome there are thin hair-like subtylostyles 0·002 mm. thick, irregularly scattered in the choanosome. These are probably the early growth forms of the larger subtylostyles. The

[1] Brondsted, H. V. (*Vidensk. Medd. Dansk Naturh. Foren.* 88, 1929) has led the way by his valuable studies on the spicule length in an individual of *Halichondria panicea* Pallas.

anisochelae, invariably in rosettes, are found in large numbers all over the sponge. The curious foreign particles which occur in great profusion in the choanosome between the spicular fibres in the holotype are singularly absent in the present specimens.

Measurements of spicules.

Subtylostyles	0·24-0·28 mm. × 0·004 mm.
Hair-like subtylostyles	0·18-0·23 mm. × 0·002 mm.
Anisochelae	0·022-0·027 mm.

Locality. Pamban, Gulf of Manaar (1-5 fathoms), (S. M. No. 685-A). The type locality, Kilakarai, is a few miles south of Pamban.

Mycale trincomaliensis, sp. nov.

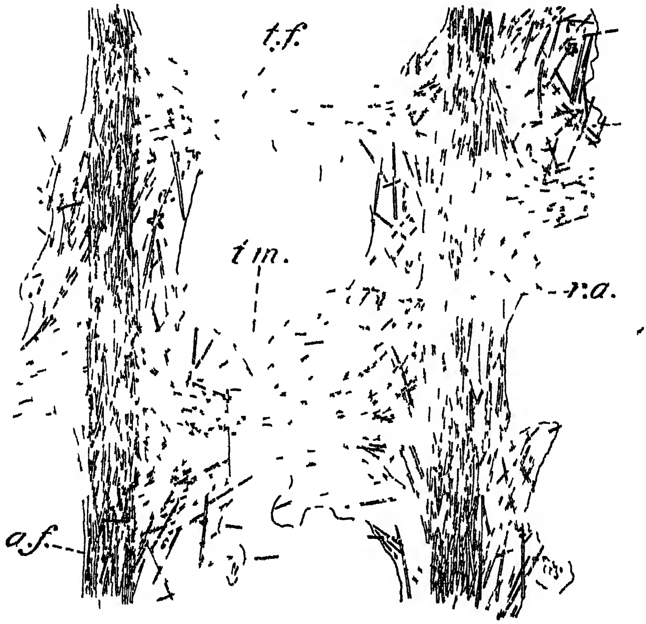
(Plate XII, fig. 19.)

A very fibrous macerated specimen, 85 mm. broad and 70-80 mm. high, is difficult to match with any previously described species of *Mycale*. It is of a pale yellow colour, compactly bushy, compressible and fragile, and has a close anastomosis of the numerous more or less vertically ascending spicular fibres with similar transverse fibres. The dermal membrane is lacking and consequently the ascending and transverse fibres are clearly visible. The ascending fibres are usually stout at the base, 1·0-1·5 mm. in diameter, hollow, and gradually narrow towards

TEXT-FIG. 23.—Skeletal fibres of *Mycale trincomaliensis*, sp. nov. *h. f.*, ascending hollow primary fibres; *s. f.*, secondary solid fibres. ×20.

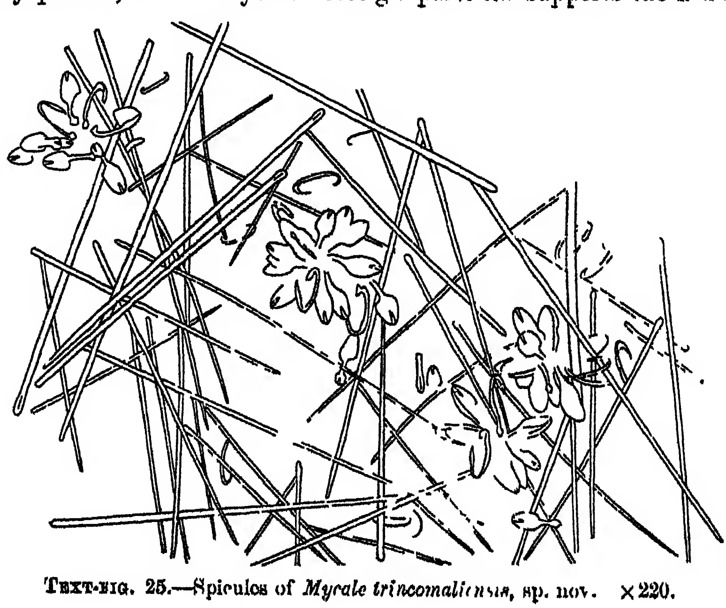
the distal extremities which are solid and end in short or long whip-like filaments. The interfibral spaces are covered by a thin transparent membrane in some places, but are usually open. In the lower parts of the sponge the fibres are covered with foreign particles of small but varied size. The secondary branches (0·1 mm.-0·2 mm. in diameter)

from the hollow main stem are solid and consist of bundles of subtylostyles which branch and anastomose to form the main skeleton (text-



TEXT-FIG. 24.—A single mesh of the skeletal fibres of *Mycale trincomaliensis*, sp. nov. *a. f.*, ascending fibres, *r. a.*, rosettes of anisochelae; *t. f.*, transverse fibres; *t. m.*, transparent membrane. ×20.

fig. 23). The megascleres of the hollow stem are disposed more or less longitudinally forming an irregular palisade of subtylostyles somewhat loosely packed, and a layer of foreign particles supports the inside of



TEXT-FIG. 25.—Spicules of *Mycale trincomaliensis*, sp. nov. ×220.

the hollow stem. At the points of origin of the solid spicular fibres from the hollow stem, and of the anastomosis of the secondary fibres the spicules spread fan-wise (text-fig. 24) The spicular elements consist of thin needle-shaped subtylostyles, occasional hair-like subtylostyles of the same length representing probably the growth stages of the needle-shaped spicules, small anisochelae, loose or in rosettes, of nearly uniform size, and large contort sigmata which are less numerous than the anisochelae. No trace of toxa has been found (text-fig. 25).

Measurements of spicules.

Subtylostyles	..	..	..	0·26-0·30 mm. × 0·0045 mm.
Anisochelae	..	..	..	0·32-0 36 mm.
Sigmata .	..	..	..	0·058 mm. chord.

Locality.—Trincomalee, Ceylon (3-10 fathoms), (S. M. No. 655).

The present species seems to be closely allied to *Mycale parishii* (Bwk.) in its branching and clathrous form, but differs in being bushy and fragile, in having both hollow and solid spicular fibres, in the form of its megascleres, in lacking toxa, and in having only one form of chelae. In the form of the subtylostyles it resembles *M. monanchorata* Burton and Rao and *M. tenuispiculata* Dendy but differs from both in the external form of the sponge.

Biemna tubulata (Dendy).

1905. *Desmacella tubulata*, Dendy, *op cit.*, p. 155, pl. ix, fig 4.
1921. *Biemna tubulata*, Dendy & Frederick, *Journ. Linn. Soc. Zool.* XXXV, p. 503.
1932. *Biemna tubulata*, Burton & Rao, *op. cit*, p. 327.

There are two pieces of sponge in the collection which belong to this species. One of them consists of two incomplete tubes closely adherent on the sides, 20 mm. high, 7-9 mm. in diameter and 1·5-2·5 mm. thick. The other is too fragmentary to be measured, but it is evident, however, that the fragments form part of a tube. Both the specimens are soft, limp, compressible and of a pale pink colour, and in these characters differ from other specimens of the species (in the collection of the Zoological Survey of India, Indian Museum) from the Andamans and Nicobars, the Mergui Archipelago, and the Pearl Oyster banks near Tuticorin. The specimens in the present collection from Ceylon seem to represent the early stages of growth of individuals of the species. The stiffness and roughness of the tubes, and the yellow or brown colour of the sponge seem to represent characters associated with growth.

Locality.- Trincomalee, Ceylon (8 fathoms), (S. M. Nos. 657-A, 657-C).

Section *MYXILLEAE.*

Strongylacidon stelliderma (Carter).

1886. *Halichondria stelliderma*, Carter, *Ann. Mag. Nat. Hist.* (5) XVIII, p. 451.
1896. *Desmacidon stelliderma*, Dendy, *Proc. Roy. Soc. Victoria*, (N. S.) VIII, p. 20.

I refer to this species with some doubt a few fragments of a sponge found on the base of a colony of *Adocia pumila* Lendfld. In external

form some of the larger fragments, at any rate, are not unlike the figure of *Strongylacidon plicatum* (Hentschel, 1911, p. 321, fig. 21*a*). They are crumb-of-bred like in appearance with more or less prominent aculeations, yellowish brown in colour, and somewhat incompressible in texture. The spicular fibres branch and anastomose and project on the surface of the sponge, the consecutive fibres being connected by a membranous tissue strengthened by large numbers of microscleres. Surface wisps of megascleres are present here and there, but the stellar nature of their arrangement round the projecting ends of the spicular fibres is not at all clear. The megascleres are thin strongyles 0·14-0·22 mm. long and 0·002-0·004 mm. in diameter. Apart from being constituents of fibres they are also irregularly scattered in the soft tissue between the fibres. They have evenly rounded ends and bear no trace of the slight inflation referred to in Dendy's account of the species. The microscleres are present in great abundance throughout the sponge, more particularly in the soft membranous tissue between the fibres. A few elongate ova are present in the tissues, but they do not bear any trace of the microscleres which are present in the spherical embryos of *S. plicatum*, a specimen of which collected by the S. W. Australian Expedition I was able to examine in the Zoological Museum at Berlin. The isochelae unguiferae are 0·009 mm. long.

The type of *Strongylacidon*, *e.g. S. sansibarense*, has anisochelae according to Lendenfeld (1897), while *S. stelliderma* and *S. plicatum* have isochelae unguiferae. Burton (1931*b*) is of the opinion that *S. plicatum* is identical with *S. stelliderma*, but Hentschel's (*loc. cit.*) figures of the former show that there are two categories of strongyles and that the microscleres have 4 or 5 denticles, whereas the latter, as far as the specimens under examination are concerned, has only 3 denticles as in the type species. The question whether these differences constitute a specific character cannot be settled until the genus is better known. The occurrence of *Strongylacidon* in Indian waters is, as far as I am aware, recorded for the first time.

Locality.—Trincomalee, Ceylon (½ fathom), (S. M. No. 651-A).

Iotrochota baculifera Ridley.

1884. *Iotrochota baculifera*, Ridley, *Rep. Zool. Coll. Alert*, p. 435, pls. xxxix, fig. M and xlii, fig. F.
1916. *Iotrochota baculifera*, Dendy, *op. cit.*, p. 125.

A massive dried specimen 200 mm. long, 140 mm. broad, and 50-60 mm. thick, and a small encrustation on a calcareous nodule belong to this species. The former is dark purple in colour, hard and incompressible, with its surface uneven and irregularly pitted. The latter is somewhat damaged and the spicular fibres of the interior are exposed up to the base of attachment. Of the spicular elements, the strongyles seem to be fewer than the others, while the birotulae are the most numerous in the membrane connecting the spicular fibres or overlying the meshes of the skeleton. The dimensions of the styles vary greatly. Strongyles 0·24-0·28 mm.×0·004-0·009 mm., styles 0·20-0·24 mm.× 0·013-0·02, and birotulae 0·0135-0·0180 mm.

Locality.—Trincomalee, Ceylon (1-5 fathoms), (S. M. No. 269).

Section *CLATHRIEAE.*

Echinodictyum clathratum Dendy.

1905. *Echinodictyum clathratum*, Dendy, *op. cit.*, p. 175, pl. xi, fig. 4.
1921. *Echinodictyum clathratum*, Dendy, *op. cit.*, p. 73.
1937. *Echinodictyum clathratum*, Burton, *op. cit.*, p. 31, pl. iv, fig. 25.

The species is represented in the collection by three complete specimens. S. M. No. 675-B from Pamban is 60 mm. high and 50 mm. broad, presumably attached to some hard object, coral or shell by a very short stalk 10 mm. high and 18-22 mm. broad at the base. The aculeated processes on the surface are 8-10 mm. high. The body of the sponge is cavernous, and its surface is covered with a smooth membrane bearing numerous minute pores and what appear to be oscula 1·5 mm. in diameter leading into a shallow pit-like depression in which a group of small openings is seen. The pores are far more numerous than the oscula and scattered all over the membrane. The aculeations on the surface bear spiny processes which are the projecting ends of the spicular fibres, and in addition brushes of thin styles which are more numerous than on the smooth membranous part supported by a loose reticulum of oxea and a few large styli. The colour of the sponge in spirit is pale brown. Polychaete worms, copepods and other small organisms are found associated with the sponge both near the pore areas and in the cavernous passages of the sponge. The present specimen more closely resembles *Echinodictyum asperum* from Tahiti (Ridley and Dendy, 1887, p. 165, pl. xxxii, fig. 2) and *E. fruticosum* from S. W. Australia (Hentschel, 1911, p. 390, fig. 53) than *E. cavernosum* from Celebes (Thiele, 1899, p. 15, pl. ii, fig. 4). S. M. No. 664 from Trincomalee is more or less spherical in outline, 72 mm. high, 80 mm. broad at the widest point and 30 mm. at the narrowest point near the base. It was apparently attached to a piece of coral rock by a broad stalkless base 20-25 mm. in diameter. The sponge is dark brown in patches on the apical part where the dermal membrane is intact, and of a pale brown or sand colour in the basal part and in portions of the apex where the dermal membrane is damaged or absent. The spicular fibres are often connected by a pale transparent membrane. The pores and oscula are not so common or clear as in S. M. No. 675-B. S. M. No. 675-A is a hemispherical honeycomb like specimen, 55 mm. long, 44 mm. broad and 36 mm. high, with the surface aculeations markedly insignificant or absent. The dermal membrane is relatively thick and the surface brushes of tylostyles more evident than in the foregoing specimens. The spicular measurements in this specimen and in S. M. No. 664 are generally higher than those of S. M. No. 675-B, as may be seen in the table of measurements given below.

Measurements of spicules in millimeters.

	S. M. No. 675-B.	S. M. No. 664.	S. M. No. 675-A.
Large styli	0·3-0·76×0·009-0·0135	0·3-0·9×0·0045-0·0135	1·00
Oxea	0·16-0·36×0·0045-0·009	0·16-0·56×0·0045-0·009	0·40
Acanthostyli	0·06-0·08×0·009	0·14-0·20×0·009	0·10
Thin styli of surface brushes,	0·20-0·28×0·0045	0·28-0·32×0·0045-0·0060	0·30

Localities.—Pamban, Gulf of Manaar (1-5 fathoms), (S. M. Nos. 675-A and 675-B) Trincomalee, Ceylon (3-10 fathoms), (S. M. No. 661).

The present species is closely related to *E. asperum*, *E. fruticosum* and *E. cavernosum* referred to above, but as Dendy (1921) has pointed out the presence of large styli serves to distinguish it from them. It is, however, not improbable that the large styli in these three species may have been overlooked on account of their scarcity. I am of opinion that *E. fruticosum* and *E. clathratum* will ultimately prove to be synonyms of *E. asperum*. *E. cavernosum*, however, seems to be distinct in its external form.

Section *RASPELIEAE*.

Prostylyssa foetida (Dendy).

1914. (*Reniera ?*) *Amorphinopsis megarrhaphea*, Hallmann, *Proc. Linn. Soc. N. S. Wales* XXXIX, p. 330, pl. xvii, figs 4, 5.
1925. *Prostylyssa siamensis*, Topsent, *Bull. Soc. Zool. France* I, p. 208.
1927. *Prostylissa*[1] *foetida*, Burton, *op. cit.*, p. 37.

There are two lots of specimens in the collection from Ceylon which belong to this species. S. M. No. 656-E has the form of a bull's head with a pair of conical inwardly curved horn-like processes, one slender and cylindrical, 16 mm. high and 7·5 mm. diameter at its base, and the other stout and pyramidal, 14 mm. high and 11 mm. diameter at base. The latter has three small conical prominences at its extremity arranged in a linear series at right angles to the base of the sponge. Fragments of coral and shell debris are imbedded in the sponge at its base, on the sides above the base, and in between the processes. The specimen is 26·5 mm. broad, 22·0-28·0 mm. high, firm and compressible, light brown to purple in colour, the latter hue being more evident on one side near the base and on the stouter horn-like process. The surface of the sponge is rough and bears depressions and pits from which the shell and coral debris have fallen off. Groups of small pores, some of them cribriform, open on the dermal membrane at the base of and on the horn-like processes. These pores and a system of branching channels are more common in the basal parts and sides of the sponge under the transparent dermal membrane. No terminal oscula are present on the horn-like processes, and the only opening which may be of an oscular nature is a small irregularly oval aperture 1 mm. in diameter at the base of the sponge. The dermal membrane is supported by a mosaic of oxea arranged more or less parallel to one another which makes the sponge surface rough, but the direction of groups of spicules at the surface varies, one group of tangential spicules being at an angle to the adjacent group. The bundles of oxea which lie at a right angle to the dermal skeleton give the specimen a slight resemblance to *Trachyopsis halichondroides* but the occurrence of styli places it undoubtedly in *Prostylyssa*. The curious mosaic-like arrangement of the dermal oxea seems to be a hitherto undescribed feature in the species, but it seems to me scarcely necessary to erect a new species to emphasise this feature. The form, texture

[1] Burton does not state why the spelling of the generic name has been changed from *Prostylyssa* to *Prostylissa*.

and colour of the species seem to be so variable that these features cannot be used to separate the present specimen from those previously referred to this species. The measurements of oxea and styli are 0·3-0·9 mm.×0·01-0·03 mm., and 0·16-0·22 mm.× 0·009 mm. respectively.

S. M. No. 666, which from its skeletal characters appears to belong to this species, consists of a few dichotomously branching fragments 24-34 mm. long and 2-4 mm. in diameter. The sponge is somewhat flattened basally and cylindrical in the distal half. The subdermal cribriform pores and the skeleton are as in the previous specimen. The colour of the sponge in alcohol is a pale yellow or white.

Locality.—Trincomalee, Ceylon (8-10 fathoms), (S. M. Nos. 656-E and 666).

Trachyopsis halichondroides Dendy.

1905. *Trachyopsis halichondroides*, Dendy, *op. cit.*, p. 147, pl. x, fig. 10.
1921. *Halichondria aplysinoides*, Dendy, *op. cit.*, p. 39, pl. 3, figs. 3-5, pl. 12, fig. 9.
1925. *Trachyopsis halichondroides*, Wilson, *op. cit.*, p. 409.
1926. *Trachyopsis halichondroides*, Burton, *Trans. Zool. Soc. London* XXII, p. 75.
1937. *Trachyopsis aplysinoides*, Burton, *op. cit.*, p. 38.

The species is represented by two specimens, one roughly cylindrical 50 mm. long and 21 mm. in diameter, and the other roughly spherical, 16-18 mm. in diameter. The colour of the sponge is pinkish brown to deep chocolate or purple, one surface being of a lighter shade than the other. The interior of the sponge is pink in colour. The sponge proper is overgrown by a layer of what appears to be a *Hexadella* which invests and masks it in several places. There is an abundance of calcareous debris of broken mollusc shells, algal nodules, bits of coral, Echinoid spines, sand grains, etc. imbedded in the substance of the investing horny sponge, and protruding at various points on the surface giving it a rough appearance externally. There is a pair of oscula at one end, one elongate and the other circular or cruciform, the former 6 mm. in maximum diameter and the latter 1-5 mm. in diameter. There are a few small pores on fleshy eminences which seem to belong to the investing horny sponge, but there are others on the uninvested portions which presumably represent the pores of the specimen under report. The skeleton consists of a dense reticulation of spicular fibres, with wisps of spicules directed towards the surface which is often supported by loose tangential spicules. In some parts the reticulate skeleton consists of thin loose fibres of only 3 or 4 spicules, while in others it consists of fairly thick fibres of several spicules. The oxea vary considerably in dimensions (0·4-0·7 mm.×0·01-0·02 mm.) and are stout in the middle tapering gradually towards the ends.

Reading through the descriptions of the species in the literature cited above, I have no doubt that the specimens in the present collection are well within the recorded limits of variation in the species both in regard to the external form and the skeleton.

Locality.— Trincomalee, Ceylon (8 fathoms), (S. M. No. 656-C).

Order KERATOSA.

Sub-order *DICTYOCERATIDA.*

Phyllospongia papyracea (Esper).

1905. *Phyllospongia papyracea* (Esper) var., Dendy, *op. cit.*, p. 217, pl. xiv, fig. 6.

There are two specimens in the collection which belong to this species. S. M. No. 266 preserved dry agrees closely with the figure and description of the Ceylon specimen examined by Dendy. It is 215 mm. long, 150 mm. broad, 1·25-2·00 mm. thick. The entire sponge colony was apparently attached to a bottom of shingle judging from the fragments of dead coral and *Arca* shells attached to the extremities of the lower surface. Several foliaceous vertical projections are present on the upper surface, while slender band shaped branches which anastomose to form arches are present on the lower surface. Many of the primary fibres contain particles of foreign matter including sand grains and broken sponge spicules, but those that stick to the sponge surface are so few and minute that they are hardly noticeable. S. M. No. 684 from Pamban preserved in alcohol consists of four sheet-like fragments of probably an entire piece. One fragment of a light yellow colour with foliaceous projections on the upper surface is attached to a small piece of dead coral by 3 short pillar-like processes of sponge from the under surface. In the other fragments of a brown colour the projections of the upper surface are small while the under surface bears several long thread-like and short pillar-like outgrowths by which the sponge was attached to a piece of coral or rock. Foreign particles are found in moderate quantities on the surface of the sponge, and in sections at right angles to the surface of the sponge a large number of sponge spicules is usually present on and among the thin fibres.

Localities.—Trincomalee, Ceylon (3 fathoms), (S. M. No. 266) ; Pamban, Gulf of Manaar (3 fathoms), (S. M. No. 684).

Spongia officinalis Linnaeus.

Plate XIII, figs. 1 and 2.)

1889. *Euspongia officinalis*, Lendenfeld, *Monogr. Horny Sponges*, p. 262.
1925. *Euspongia officinalis*, Wilson, *op. cit.*, p. 484.
1934. *Spongia officinalis*, Burton, *op. cit.*, p. 576.

There are two flat cake-like specimens in the collection which belong to the present species. The larger of the two was apparently attached to the convex surface of a submarine rock or coral mass, and its base of attachment is therefore concave. It is roughly pentagonal in outline, 70 mm. high, 85 mm. broad and 15 mm. thick with its distal margin marked off into four triangular prominences 10-15 mm. high which are darker in colour than the rest of the sponge. The numerous very short conuli connected by membranous ridges of a somewhat muscular consistency give the surface its reticulated and rough appearance. The darker portions of the sponge bear several oscula 3-5 mm. in diameter on the distal margin of the sponge and at or near the bases of the triangular prominènces. The dermal membrane is transparent and entire even on some of the oscula. The other specimen is 90 mm. high, 45 mm.

broad, and 10 mm. thick and is roughly rectangular in outline with the distal margin indented into two large and two very small conical prominences. Its base of attachment is 40 mm.×28 mm. There are one large and two small oscular openings on the darker portion of the sponge with the transparent dermal membrane entire in all but one. The texture of both the specimens is firm and compressible. The primary fibres terminating in conules are knotted, and 0·06-0·08 mm. in diameter, and the anastomosing secondary fibres are thinner, and 0·02-0·04 mm. in diameter. The primary fibres have usually a core of broken spicules.

Locality.—Trincomalee, Ceylon (3-10 fathoms), (S. M. No. 653).

Spongia officinalis var. **fenestrata,** nov.

(Plate XIII, figs. 3 and 4.)

A specimen from Pamban which in texture and structure closely resembles *S. officinalis* described above differs from it in having a distinctive fenestrated dermal membrane, not unlike that figured by George & Wilson (*Bull. U. S. Bur. Fish.* XXXVI, pl. lxv, fig. 48, 1919) for their *Aplysilla longispina.* It is 80 mm.×55 mm., and 37 mm. high, somewhat bun-shaped, and attached presumably to a small rounded piece of coral which has left a cavernous oval hollow 34 mm.×26 mm. and 22 mm. deep on the under-surface of the sponge. There are a few digitate processes, 5-25 mm. high and 3-10 mm. in diameter, at various levels projecting from its basal and distal portions like a group of chimneys. A few oscula 1·5-6·0 mm., found on various parts of the sponge except the extremities of the digitate processes, lead to the interior of the sponge but rarely communicate with the cavernous basal part of the sponge or its extensions. The upper surface of the sponge is rough in general appearance due to the presence of the numerous minute conuli and is covered by a characteristic fenestrated, granulated, more or less

TEXT-FIG. 26.—Skeletal fibres of *Spongia officinalis* var. *fenestrata,* nov. a. View of a surface conule with the trellis-membrane and supporting spicules; b. View of vertical section of the sponge near the surface showing the distribution of the sponge fibres. *o.*, openings in the transparent membrane; *s. c.*, surface conules.

transparent membrane supported by scattered broken spicules of various sponges. On the basal portion of the sponge, however, the membrane is without the fenestrae. The colour of the sponge varies from light

to chestnut brown on the upper surface to pale white on the under. The interior of the basal cavity is yellowish. The texture of the sponge is compressible though firm. The primary and secondary skeletal fibres are hardly distinguishable except by the presence in the former of a core of broken sponge spicules. The primary fibres ending below a group of conules often divide into subsidiary branches, one for each of the conules in the group. Sometimes more than one branch are given off to individual conules from the tip of which they project considerably. These projecting fibres give the woolly appearance seen in some parts of the sponge. The secondary fibres form a close reticulum throughout the sponge.

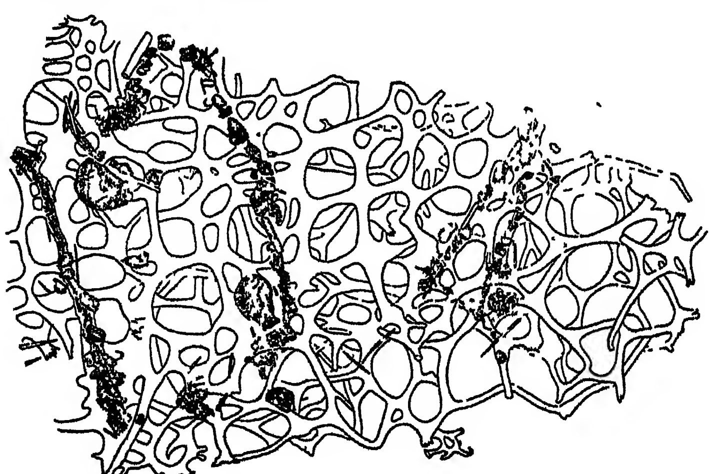
Although the sponge has some distinctive features which may justify its separation from *S. officinalis*, it is hardly necessary to give it more than a varietal status.

Locality.—Pamban, Gulf of Manaar (5 fathoms), (S. M. No. 676).

Spongia officinalis var. **bibulus,** nov.

(Plate XIII, figs. 5 and 6.)

The specimen described here as a new variety would, according to Lendenfeld and Dendy, have belonged to the genus *Hippospongia* Schulze, but following Burton I prefer to assign it to *Spongia* Linn. It does not agree exactly with the published descriptions or figures of any of the species of *Euspongia* or *Hippospongia* hitherto known, but I do not think that the differences are such as to warrant the creation of a new species. I have, however, separated it from *S. officinalis* as a distinct variety with reference to the tendency of the sponge to absorb fluids quickly resulting in its rigidity.



TEXT-FIG. 27.—Primary fibres of the deeper portions of the skeleton of *Spongia officinalis* var. *bibulus*, nov. ×22·5.

There are two flabellate fragments of the sponge in the collection. One is roughly hexagonal in outline, 90 mm.×70 mm., 2-18 mm. thick, and the other triangular, 62 mm. at its base, 52 mm. and 60 mm. long on the other two sides, and 10-15 mm. thick. A surface view of the

former from above and a side view of the latter are shown in plate XIII, figs. 5 and 6. Both are attached by their smooth base to a few fragments of calcareous algae. A number of band-shaped trabeculae of reticulated spongin fibres arises from the upper surface of the sponge anastomosing to form cavernous passages. These trabeculae are produced over the anastomoses into lamellate or roughly cylindrical branches into which the primary fibres and their branches enter. The meshes between the fibres of the basal plate are smaller than those of the trabeculae. The fibres of the flat base of the sponge are pale and transparent, 0·02-0·04 mm. in diameter with the primary fibres 0·06 mm. in diameter. The peripheral fibres are of an amber yellow to brown colour, 0·02-0·08 mm. in diameter, with the primaries 0·06-0·10 mm. in diameter, and a core of pith 0·02 mm. in diameter. The primary fibres are cored by sand grains, sponge spicules and other foreign bodies, and their outlines are not always clearly distinguishable. Particles of fine matter may

TEXT-FIG. 28.—Primary fibres of the surface skeleton of *Spongia officinalis* var. *bibulus*, nov. ending in conuli. ×24.

also be sticking in a row to the outer sides of the fibres. The secondary fibres are free from inclusions. Certain rusty brown *Nostoc*-like algal filaments are sometimes found lodged in the fibres.

The sponge is rigid and incompressible in alcohol, but soft, compressible and elastic when dry. The moment the dry sponge is put into alcohol, it takes up the preservative very rapidly becoming at the same time very rigid and incompressible.

Locality.—Trincomalee, Ceylon (3-10 fathoms), (S. M. No. 654-A).

Hircinia fusca Carter.

1905. *Hircinia fusca*, Dendy, *op. cit.*, p. 219, pl. xiv, fig 1.
1937. *Hircinia fusca*, Burton, *op. cit.*, p. 40.

The specimen agrees with the detailed general description of the species given by Dendy. It is 160 mm. high 65 mm. broad, and fixed, by a more or less flat base, 100 mm.×75 mm., presumably to a coral mass or the hard sandy surface of the sea-bottom, as a thin layer of sand particles adhering to the base suggests. It consists of flabellate and two digitate processes. The latter stand apart from the former and appear to have been formed by the fusion in the early stages of growth of three or four digitate processes judging from the number of terminal oscula present. The conules are arranged in longitudinal series on the sponge, the distance between two consecutive conules being 3-13 mm. They are 1·5-3·0 mm. high, each consecutive pair in the longitudinal series being connected by an arched ridge. Besides the terminal oscula there are large ones 6-10 mm. in diameter on the side of the sponge and at the base of the digitate processes, into the cavity of which open 2-4 smaller oscula. The basal part of the sponge is somewhat paler than the upper portions which are of a dark brown colour. The conules are supported by an anastomosis of stout fibres cored by broken sponge spicules. The filaments characteristic of *Hircinia* seem to form fibres below the ectosome with broken spicules entangled between them. In the choanosome large grains of sand, Formaniferan shells, and spicules of Alcyonaria are attached to the fibres. The dermal membrane is studded with broken spicules of sponges.

Locality.—Pamban, Gulf of Manaar (3 fathoms), (S. M. No. 679).

Hircinia ramodigitata Burton

(Plate XIII, fig. 7.)

1934. *Hircinia ramodigitata*, Burton, *op. cit.*, p. 500, pl. i, fig. 12.

There are two specimens in the collection, one preserved in alcohol and the other preserved dry, which belong to this species. S. M. No. 267 from Trincomalee is a colony of anastomosing tubes some of which are vertical and 10-70 mm. high. The colony is 100-140 mm. long and 75-95 mm. broad. The diameter of the individual tubes varies from 5 to 20 mm., and of the oscula from 5 to 10 mm. The sponge wall in the hollow tubes is 3-5 mm. thick. The pores on the surface of the sponge are 1-5 mm. in diameter and usually more numerous on the dorsal than on the ventral side. The distal ends of the tubes may have pores or oscula. The latter are rounded, oval or hour-glass shaped. A parchment-like membrane often covers the pores. The colour of the sponge is dirty gray or brown. Most of the primary fibres are cored by particles of sand and a few broken sponge spicules.

S. M. No. 691 from Pamban is a branched colony of tubular sponge with minute surface conulations and conspicuous oscula of various sizes scattered over the sponge, and sometimes oscular sieves on the distal extremity of the digitate processes. The external form of the specimen resembles *Psammoclema ramosum* (Marshall in *Zeit. Wiss. Zool.* XXXV,

pl. vii, figs. 12-15, 1880), and of the same species figured by Poléjaeff (*Challenger Rep.* XI, pl. iii, fig. 8, pl. iv, fig. 1, 1884). The diagnosis of *Psammoclema* as given by Marshall is hardly adequate to enable any detailed comparison with the present specimens. The whole colony seems to arise from a small plate-like horizontal mass of sponge attached to a coral mass or debris. It is more or less dichotomously branched, non-anastomosing, 120 mm. high with the digitate branches 20-25 mm. high, 12-20 mm. in external and 10-18 mm. in internal diameter, and the sponge-wall 1·5-1·0 mm. thick. Oscula are scattered all over the sponge and vary in diameter from 1 mm. to 10 mm. The digitate branches may have at their extremities oscular sieves 14 mm. in diameter with individual oscula 3-4 mm. in diameter. The oscula may be open, or wholly or partly covered with a whitish semi-transparent membrane. Some of them lead into shallow or deep cavities into which open a few rounded exhalent apertures. The external surface is minutely conulated with the conules 0·1-0·2 mm. high. In the solid portions of the colony where the internal cavity is just beginning to be formed, the disposition of the primary and secondary fibres is clearly seen. The primary fibres radiate like the spokes of a wheel to the periphery of the sponge while the secondary fibres form a regular reticulum with the primary fibres. The meshes of the reticulum are more or less rectangular and fairly compact. The outlines of the primaries are obscured by the mass of sand grains and other debris which fill them, but the secondaries are well formed. The distinction between the primary and secondary fibres lies only in the presence of coring debris in the former, the diameter of the latter being sometimes more than that of the primary fibres. The fibres vary in diameter from 0·02 mm. to 0·06 mm. The characteristic dermis described by Burton is present in the specimen, but I have not been able to find any filaments or algae in the tissues, although the choanosome is filled with a granular substance.

A small species of crab, *Porcellana* sp., and several small polychaete worms were found in the cavity of one of the branches of the sponge.

It is probable that *Psammoclema* Marshall, which is not a well-defined genus, will ultimately prove to be a *Hircinia*. *P. ramosum* and *P. vosmaeri* are so like the Ceylon specimens of *Hircinia ramodigitata* described here in external and internal features that they may also prove to be identical with the latter, or, at best, varieties of it. The arrangement of the dermal debris in a polygonal reticulation seems to be the only distinctive character of the present species, and this is hardly such an important character as to distinguish it from *Hircinia variabilis* (Schulze), of which it may prove to be only a variety.

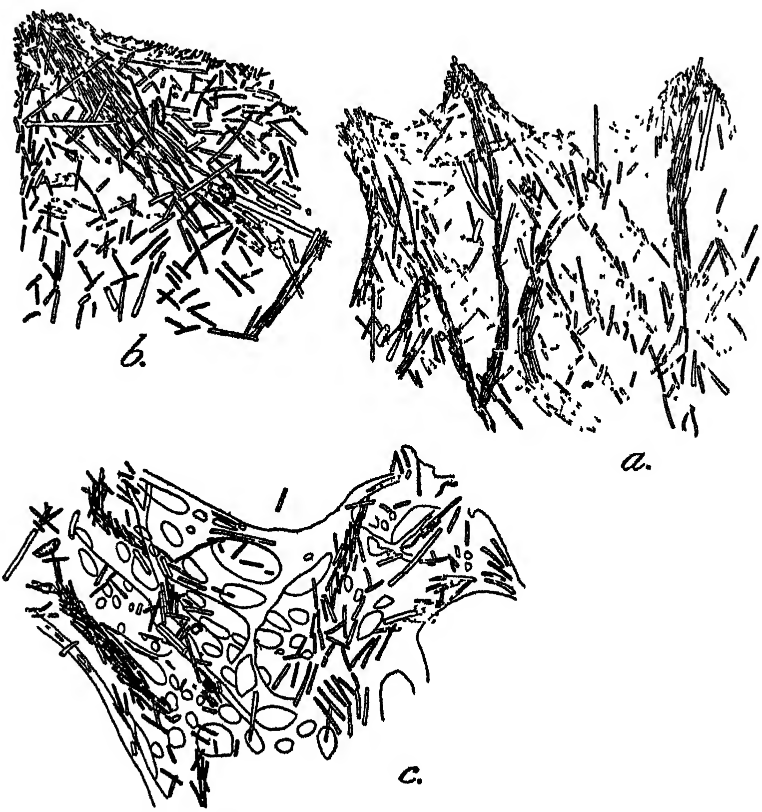
Localities. Pamban, Gulf of Manaar (5 fathoms), (S. M. No. 691); Trincomalee, Ceylon (3 fathoms), (S. M. No. 267).

Hircinia cactiformis, sp. nov.

(Plate III, fig. 8.)

A small cake-like specimen 65 mm. long, 35-45 mm. broad, and 30 mm. high with a number of cactiform processes on its upper surface does not match with any known species of *Hircinia*. The sponge was

apparently found on a bottom of shell and coral debris or sand judging from the number of calcareous and flinty particles attached to the under surface of the sponge. The ventral surface is more or less convex and bears elongate canalicular excavations in the sponge substance inhabited by Polychaete worms. Two small Pelecypods are also found in a pit-like excavation on the sides near the base. The dorsal surface is more or less plane and has on or about the centre a stout, cylindrical, pillar-like slanting process 20 mm. long and 15 mm. in diameter, and a number of short cactiform[1] or aculeate processes, 3-15 mm. long and 1-1 mm. in diameter, also projecting at an angle to the dorsal surface. The rest of the sponge surface is granular. There are no definite pores, but two small oscula 1·0-1·5 mm. in diameter are present, one at one end of the sponge near the base and the other on the summit of the pillar-like processes hidden among the cactiform conules. The sponge is



TEXT-FIG. 29.—Skeletal fibres of *Hircinia cactiformis*, sp. nov. a. Digitate process of the surface with terminal conules; b. Surface conule of sponge with a core of radiating spicules; c. Vertical section of sponge near surface with ascending fibres cored with broken spicules.

soft, flabby, and compressible. The dermal membrane is transparent, and the fibres of the skeleton can be easily seen through it, more parti-

[1] The cactiform processes are not unlike the stems of certain Xerophytes of the atural order Euphorbiaceae.

cularly on the cactiform processes. The skeleton consists of diaphanous, frequently branching and anastomosing spongin fibres, cored completely or partially by sponge spicules. The fibres are very irregular in outline and vary in diameter from 0·06 mm. to 0·20 mm. They end in the conules on the processes. The dermal membrane is supported by short broken sponge spicules which are usually disposed along the axes of the processes. The long filaments with bulbous terminations believed to be characteristic of the genus occur in great abundance in between the skeletal fibres. In some places they lie side by side so closely as to form a mat like structure.

The species is to be distinguished from previously described species of *Hircinia* chiefly by the external form of the sponge and the pale, transparent dermal membrane investing the entire sponge.

Locality. Pamban, Gulf of Manaar (5 fathoms), (S. M. No. 677).

Hircinia pellita, sp. nov.

(Plate XIII, fig. 9.)

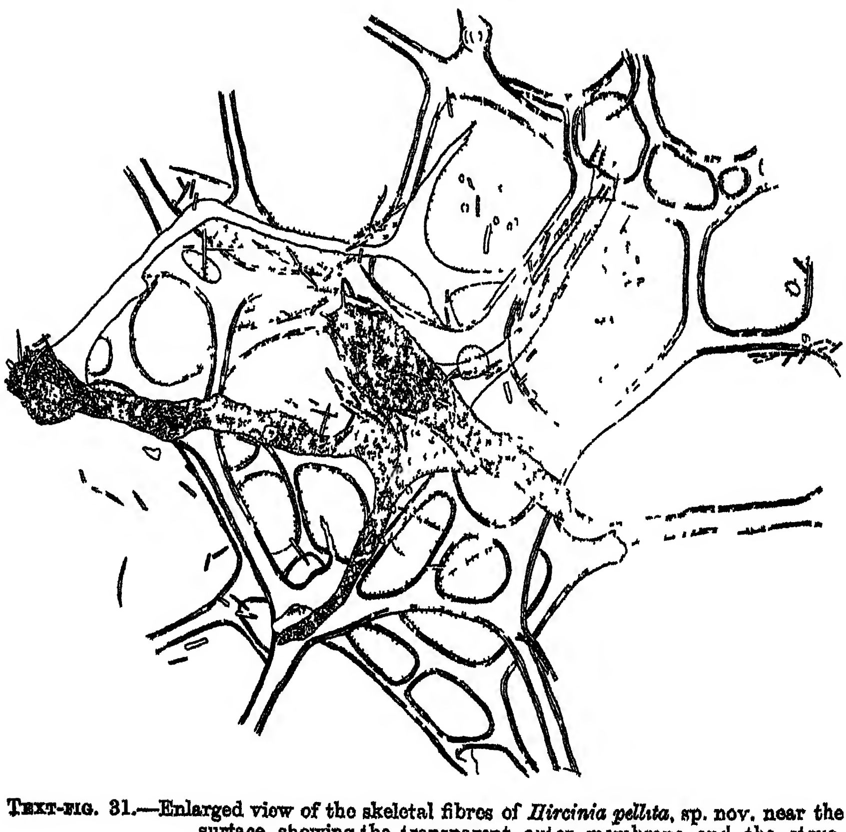
Sponge clathrous; firm but compressible, consisting of anastomosing bands of a network of spongin fibres; primary and secondary fibres not easily distinguishable in the interior bands, but near the surface they are quite distinct. The primary fibres are generally knotted and

TEXT-FIG. 30.—Vertical section through surface of *Hircinia pellita,* sp. nov. showing the primary and secondary skeletal fibres and the conules. ×26·6.

angulated in places owing to the irregular disposition of the enclosed fragments of spicules which often project outside the fibre. Some

distance below the surface they branch out fan-wise supporting a group of minute surface conules. The entire sponge surface is covered by a transparent pale white membrane which shows out conspicuously in between the bands of spongin fibres and conforms to the polygonal pattern of the surface meshes by being raised as ridges connecting the conules On the under surface of the sponge the membrane is so transparent and smooth that the surface meshes of fibres are clearly visible through it. Oscula are present on the margin of the sponge, and minute pores in between the conules. The dermal membrane is supported by scattered broken spicules of sponges and by other foreign matter which may, in places, be arranged in a reticular pattern. The characteristic anastomosis of the secondary with the primary fibres may be seen clearly near the surface, and more particularly below the surface conules. The deeper secondary fibres are conspicuously laminated with the central pith only a third of the diameter of the entire fibre. Peripheral fibres are pale in colour while the deeper ones are yellowish. The large branching cavities which intercommunicate in the interior of the sponge, the finger-shaped processes, and the investing dermal membrane give the sponge its resemblance to a glove.

The sponge was, probably, taken on a substratum of coral or shell debris fragments of which are sticking to what is presumably the basal



TEXT-FIG. 31.—Enlarged view of the skeletal fibres of *Ircinia pellita*, sp. nov. near the surface showing the transparent outer membrane and the structureless fibrous tissue. ×49·3.

part of the sponge. The holotype is roughly pentagonal in shape, 114 mm. in diameter and 30 mm. thick. On the periphery of the sponge there are stout digitiform processes, 10-45 mm. high and 15-25 mm. in diameter, on the extremity of which are one or more oscula 4-5 mm. in diameter. Oscula are also present on other parts of the sponge, one of which on the upper surface 10 mm. in diameter appears to be the central or main osculum (see centre of fig. 9 in plate XIII). The small conules, 1-2 mm. high, are generally present on the upper surface and periphery of the sponge, and are supported by the terminal branches of the primary fibres. The bands of sponge fibres are 3-5 mm. thick, with the primary fibres 0·04-0·16 mm. and the secondary fibres 0·04-0·12 mm. in diameter, and the meshes of the reticulating fibres 0·10-0·15 mm. in diameter. No filaments are present in the choanosome, but their place seems to have been taken by a structureless fibrous tissue which is found all over the interior of the sponge and below the dermal membrane.

In the form of its skeleton the species closely resembles Poléjaeff's *Cacospongia irregularis* and *Hippospongia anomala* both of which are probably *Hircinia*, but in the glove-shaped external form and in the occurrence of a transparent dermal membrane which reveals the clathrous internal structure of the sponge, the present species seems to differ from all other *Hircinia* hitherto described.

Locality.—Trincomalee, Ceylon (3-10 fathoms), (S. M. No. 652).

Dysidea fragilis (Montagu).

1905. *Spongelia fragilis* var. *ramosa*, Dendy, *op. cit.*, p. 208.
1931. *Dysidea fragilis*, Burton, *op. cit.*, p. 583, pl. ii.
1937. *Dysidea fragilis*, Burton, *op. cit.*, p. 41.

Of the three specimens in the collection belonging to the present species, S. M. No. 270 from Trincomalee is a colony of dried sponge which has been reduced to powder owing to its extreme fragility. A few digitiform fragments which somewhat resemble a specimen from the British coast figured by Burton (1934, pl. ii, fig. 8) are, however, still intact. The lumen of the skeletal fibres are so crammed with sand grains, Foraminiferan remains, and sponge spicules that their outlines are hardly discernible. The inclusions of the fibres project into the meshes which are often covered by a very thin membrane with whitish granular markings.

The other two specimens from Pamban are preserved in spirit. S. M. No. 685-B is a flat sheet-like sponge attached by a broad base from which a few short processes arise. The whole sponge surface is studded with small conules supported by the distal terminations of the primary fibres. Particles of a darkish colour and grains of sand are found sticking to the sponge. The specimen is flabby, compressible, and of a pale dirty brown or grey colour. S. M. No. 675-C is of a firmer texture and a more decidedly pale dirty brown colour. Large channels or conduits passing through the interior of the sponge give it a cavernous appearance. The soft structureless membrane between the conules on the surface and near the channels bears small or large apertures leading into the cavernous interior. The conules are less conspicuous and the black particles less numerous than in S. M. No. 685-B.

Localities. Trincomalee, Ceylon (1-5 fathoms), (S. M. No. 270); Pamban, Gulf of Manaar (1-5 fathoms), (S. M. Nos. 685-B and 675-C).

Dysidea herbacea (Keller).

(Plate XIII, fig. 10.)

1889. *Spongelia herbacea*, Keller, *Zeit. Wiss. Zool.* XLVIII, p. 336, pl. xx, fig. 1.
1902. *Spongelia digitata*, Sollas, I. B. J., *Proc. Zool. Soc London*, p. 220, pl. xiv, fig. 4, pl. xv, fig. 2.
1934. *Dysidea herbacea*, Burton, *op. cit.*, p. 593.

Three specimens in the present collection agree closely with the figure of the Malayan specimen on which Sollas based her description of *Spongelia digitata.* They cover small masses of calcareous nodules in the form of flabby sheets of pale tissue with lamellate or digitate projecting processes, 20×10×2 millimetres, with a series of low surface tubercles arranged in some parts in regular rows. The primary spicular fibres seem to terminate under these tubercles. The skeleton consists of an irregular anastomosis of pale or transparent spongin fibres the presence of which is indicated by the few broken sponge spicules, sand, and other foreign bodies which core the fibres. The relatively thick dermal membrane is supported by similarly cored branching surface fibres. Oscula few, elongate-ovate, and found in between the digitate processes. Most of the rounded openings present on the surface of the sponge are the mouths of small vermetid tubes of which there are several sticking to the calcareous nodules. The sponge is filled almost entirely with the filaments of an alga[1] packed together to form in places continuous sheets of tissue.

Locality.— Trincomalee, Ceylon (8 fathoms), (S. M. No. 657-A).

Luffariospongia clathrata (Carter).

1881. *Hircinia clathrata*, Carter, *Ann. Mag. Nat. Hist.* (5) VII, p. 366.
1905. *Hippospongia clathrata*, Dendy, *op. cit.*, p. 215, pl. xiv, fig. 2.
1937. *Luffariospongia clathrata*, Burton, *op. cit.*, p. 41.

S. M. No. 681-A, preserved in alcohol and of a deep brown colour, seems to agree with the descriptions of the Indian and Ceylonese specimens given by Carter and Dendy, more especially the latter. It is 55 mm. high and 88 mm. in maximum diameter. The sponge was presumably attached by a short stout stalk 8 mm. high and 15 mm. in diameter. It has five digitate processes 25-40 mm. long and 15-20 mm. in diameter. The hollow of the stalk is cored by a mass of firmly agglutinated large sand grains which seems to support the stalk. A dead gastropod shell is enclosed by the growing sponge between two of the processes. The rough appearance of the upper surface of the sponge is due to small aggregations of sand grains present here and there. The large oscular openings are confined to the under surface of the sponge although a few of them are found in the centre of the upper surface as well. The ectosomal tympanic membranes have been torn off from their position at many points, but traces of them can be seen at the entrace to the openings. The yellowish surface fibres are relatively thin

[1] This alga has been identified as *Phormidium spongeliae* (Schulze) Gomont by Prof. M. O. P. Iyengar, Director of the University Botany Laboratory, Madras, to whom my thanks are due.

while the yellowish brown deeper fibres are stout. The primary fibres are 0·06-0·08 mm., and the secondary fibres 0·04-0·06 mm. in diameter. A few fibres which occasionally dichotomously branch and run parallel in ascending to the surface contain inclusions of sand grains and broken sponge spicules while the intermediate fibres are without them.

Locality.—Pamban, Gulf of Manaar (3 fathoms), (S. M. No. 681-A).

The synonymy of the species given by Burton in the reference cited is somewhat confusing. In his Report on the Great Barrier Reef Sponges (1934) he mentions *Hircinia clathrata* Carter (1881) and *H. clathrata* Dendy (1889) under the synonymy of *Carterispongia clathrata* (Carter), but in the present reference (1937) under *L. clathrata* he omits *Carterispongia clathrata* without comment. It seems doubtful if *Luffariospongia* can stand well-differentiated from *Spongia*. The dichotomous branching fibres which run more or less parallel for some distance below the periphery of the sponge seems to point to its probable relationship to *Polyfibrospongia* Bowerbank through forms like the present species [cf. de Laubenfels (1936, *Papers from Tortugas Laboratory* XXX, p. 14), and Kirkpatrick (1900, *Ann. Mag. Nat. Hist.* (7) VI, p 358, pl. xv, fig. 2)].

Aplysinopsis reticulata Hentschel.

(Plate XIII, figs. 11 and 12.)

1912. *Aplysinopsis reticulata*, Hentschel, *Abhandl. Senckenb. Naturf. Gesellsch.* XXXIV, p. 437, pl. xv, fig. 1; pl. xvi, fig. 9.
1937. *Aplysinopsis reticulata*, Burton, *op. cit.*, p. 42.

Three specimens in the present collection belong to this species. One of the two from Pamban is in a greatly macerated condition, but its characteristic skeleton seems to leave no room for doubt.

S. M. No. 662 from Trincomalee is a roughly conical fragment 59 mm. high, 54 mm. broad, and 29 mm. thick with an arched base by which it was apparently attached to a fragment of a coral mass. A few fragments of calcareous algae are still attached to the bottom of a small cavity on the sides above the arched base of the sponge. The colour of the sponge in alcohol is coffee or chocolate brown. The surface of the sponge bears a cellular appearance owing to the formation of polygonal facets by the anastomosis of the surface fibres. The vertical fibres at the junctions of anastomosis project above the surface of the sponge, and may be simple or branched. The meshes between the fibres are covered by a thin but tough membrane which sometimes bears what may represent small rounded pores. Oscula 3-5 mm. in diameter and as many millimeters deep with a few smaller oscula at the bottom of the pits are present on both sides of the sponge. The surface fibres are yellowish brown in colour, and the texture of the sponge is firm though very slightly compressible. The primary ascending fibres are 0·10-0·20 mm. in diameter while the secondary fibres are 0·04-0·14 mm. in diameter. The central pith of the fibres varies in diameter accordingly from 0·06 to 0·10 mm. The foreign sponge spicules of the primary fibres do not quite fill the central core. The surface membrane is structureless, firm, and has a few scattered supporting foreign sponge spicules. The choanosome of the deeper parts of the sponge has, however, a minute cellular structure.

S. M. No. 673 from Pamban is somewhat similar to the specimen described above, but has a more definite triangular outline with two tall chimney-like outgrowths from one side. The sponge was presumably attached to the overhanging ledge of a sea-grotto as the concave surface of attachment on one side indicates. This surface bears traces of calcareous nodules, dead bivalves, and sand grains. The side which may have been facing the interior of the grotto and is probably the older part of the sponge is of a greyish brown colour, while the side which bears the outgrowths and was probably facing away from the grotto is of a chocolate brown colour. The cellular markings on the surface are prominent and the ascending fibres are only rarely produced above the surface of the sponge. The specimen is 85 mm. high and 88 mm. broad at base, with the chimney-like outgrowths 64 mm. high and 10 mm. broad at base. There is a long closed conduit 10 mm. in diameter running along the base of the inner chimney-like outgrowth which opens on both sides. The ascending fibres in the conduit end in small knobs, and the fact that the cellular structure and the trellis-like membrane are present in this conduit also indicates that the sponge surface in the conduit was external and has since been covered by the growing sponge. A few well-defined small rounded pores are also present in the trellis-like surface membrane. There is no osculum unless an elongate deep pit at the base of attachment of the sponge with smaller openings at its bottom represents it. The fibres are of the same dimensions as in S. M. No. 662, but have a dark granular pigment which cores or completely fills up the secondary and nearly all the ascending primary fibres obscuring the sponge spicules and other foreign bodies. The fibres form an irregular reticulation.

S. M. No. 678 from Pamban consists of two macerated fragments, one cake-like and roughly pentagonal, 60 mm. high and nearly as broad, and the other roughly pyramidal 68 mm. broad at base, 18 mm. thick, and 43 mm. high. The dermal membrane is more or less completely macerated so that the stout primary ascending fibres and the secondary anastomosing fibres appear like the stumps and branches of trees in a deciduous forest. The texture of the sponge is firm and incompressible. The colour of the sponge is golden brown with the anastomosis of secondary fibres in some parts of the sponge pale yellow or more or less bleached in appearance. Fragments of calcareous nodules and barnacle shells are found deeply imbedded in the sponge. The primary ascending fibres are 0·20-0·30 mm. in diameter with a core (0·06-0·10 mm. in diameter) of loosely packed sponge spicules. The secondary fibres are 0·02-0·16 mm. in diameter and form an irregular reticulation.

Localities.—Trincomalee, Ceylon (8-10 fathoms), (S. M. No. 662); Pamban, Gulf of Manaar (3-6 fathoms), (S. M. Nos. 673 and 678).

Spongionella tubulosa Burton.

(Plate XIII, fig. 13.)

1937. *Spongionella tubulosa*, Burton, *op. cit.*, p. 42.

To this species I refer with some doubt a brown-coloured, completely macerated, alcohol-preserved specimen, 32 mm. high, 44 mm. broad.

It has a number of short stout digitate processes 8-14 mm. high, 10-15 mm. broad, each terminating in a circular osculum 3-5 mm. in diameter. The specimen was apparently attached to the convex side of a bivalve shell or to a piece of coral, and its base is consequently concave. With the dermal membrane absent, the surface of the sponge is rough to the touch owing to the projecting end-fibres of the surface reticulation. The texture is compressible and resilient. The skeleton is a more or less regular reticulum of anastomosing fibres enclosing usually quadrangular or triangular, and often polygonal meshes between them. The fibres are golden yellow in colour and vary in diameter from 0·02 to 0·16 mm. with the pith in the stouter fibres 0·06-0·08 mm. in diameter. The fibres and pith resemble those of *Megalopastas pulvillus* Dendy (1905, pl. xv, fig. 3).

Sub-order *DENDROCERATIDA.*

Hexadella purpurea Burton.

1900. *Psammopemma purpureum*, Kirkpatrick, *Ann. Mag. Nat. Hist.* (7) VI, p. 358.
1937. *Hexadella purpurea*, Burton, *op. cit.*, p. 43[1].

I refer to the present species a small triangular flabellate mass 8 mm. thick, with equal sides 28-30 mm. long. It is soft, compressible, fleshy and smooth, and is attached to some calcareous debris by one of its corners. Small particles of the debris are also found imbedded in the substance of the sponge. A small Dromiid crab[2], *Polyonyx hendersoni* Southwell, is found lodged in a cavity excavated by its activity on the under surface of the sponge. Elongate or oval openings by which the crab seems to be in communication with the outside world are present on the surface of the sponge. Apart from these openings there do not seem to be any oscula proper. A few minute pores less than a millimeter in diameter may be seen in groups of two or more in a few places on the surface. A few mamillate processes projecting from the surface may also be observed on the sponge.

Locality.—Trincomalee, Ceylon (8 fathoms), (S. M. No. 656-B).

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[1] In this reference Burton has unfortunately omitted mention of Kirkpatrick's paper (1900) on the Funafuti Sponges in the Bibliography given at the end of the paper on p. 47.

[2] For the identification of crabs found in the sponges of the present collection I am indebted to my colleague, Dr. B. N. Chopra. This crab has been previously recorded from the Gulf of Manaar in the cavities of sponges, and of dead coral rock.

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EXPLANATION OF PLATE XII

Indian and Ceylonese Tetraxonid Sponges

Callyspongia cellaria, sp. nov.

FIG. 1. Side view of a piece growing on dead shell. $\frac{2}{3}$
FIG. 2. View of cut surface of another piece of sponge. '
FIG. 3. View of upper surface of a small sponge.
FIG. 4. View of cut surface of the same sponge. ,
FIG. 5. View of cut surface of a cylindrical piece of sponge at its base $\times\frac{2}{3}$.
FIG. 6. View of cut surface of the same at its extremity. $\frac{2}{3}$
FIG. 7. A club-shaped piece of sponge viewed from a side. $\frac{2}{3}$

Callyspongia cellaria var. **fusca,** nov.

FIGS. 8 and 9. Side view of two specimens showing rounded oscula $\times\frac{1}{3}$.

Callyspongia pambanensis, sp. nov.

FIG. 10. A lamellar form of the sponge viewed from the surface. $\frac{2}{9}$
FIG. 11. View of cut surface of another piece of the sponge. .
FIG. 12. A cylindrical form of the sponge viewed from the side. × .

Callyspongia obtusispiculifera (Dendy)

FIG. 13. A much-branched dried specimen viewed from the side. $\times\frac{1}{3}$

Callyspongia diffusa (Ridley)

FIG. 14. A macerated dried specimen viewed from above. $\times\frac{1}{2}$.

Stelletta bocki, sp. nov.

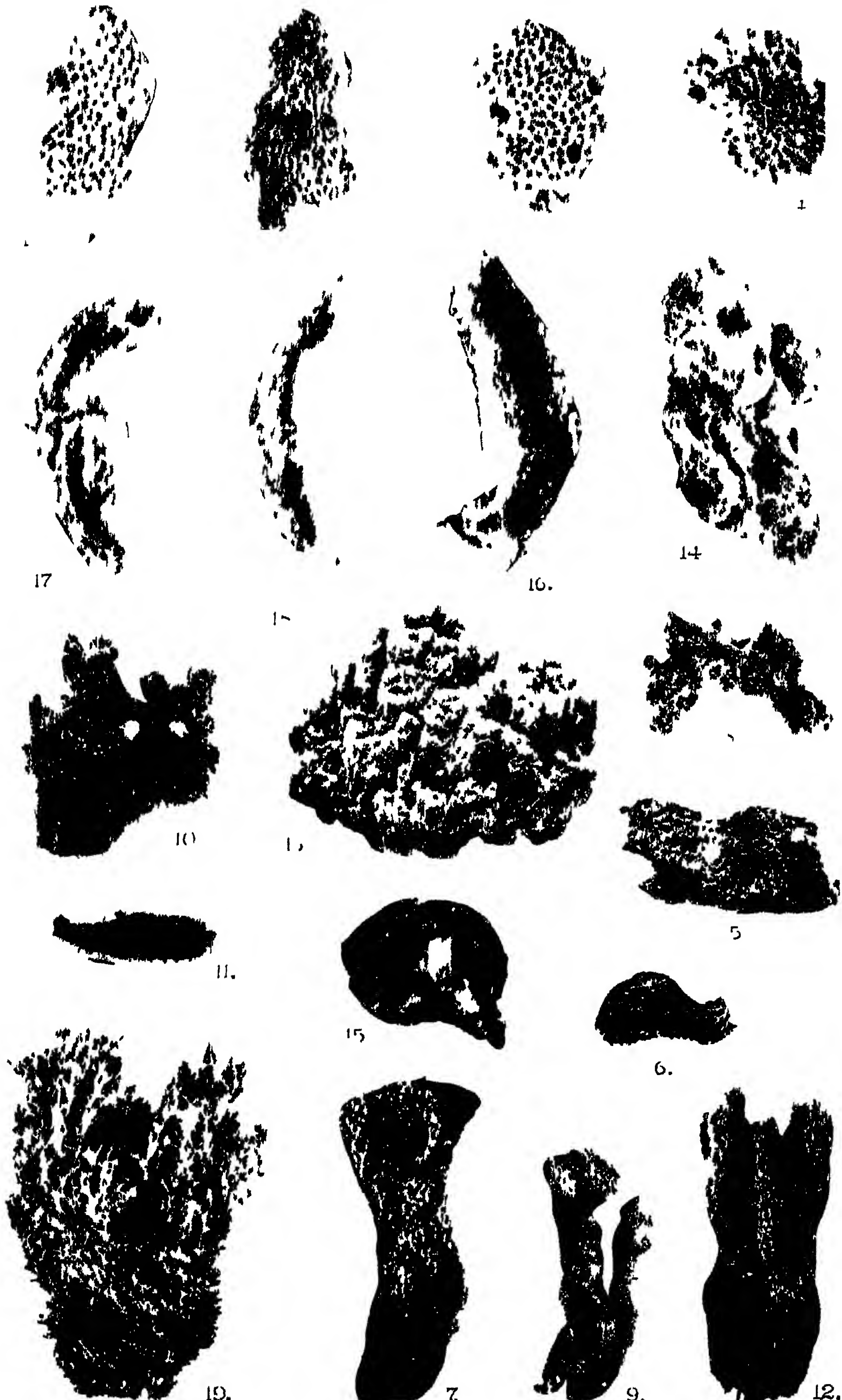
FIG. 15. Ventral view of the Holotype. The specimen has been cut into two in the centre. $\times\frac{2}{3}$

Oceanapia arenosa, sp. nov.

FIG. 16. View of convex outer surface of the Holotype. $\times 2$
FIGS. 17 and 18. Interior view of the two pieces of the sponge resulting from a median longitudinal cut showing the sand-lined central cavity. $\times 2$.

Mycale trincomaliensis, sp. nov.

FIG. 19. Surface view of the Holotype preserved in alcohol. $\times\frac{2}{3}$



S. C. Mondul, Photo

Indian and Ceylonese Tetraxonid Sponges.

EXPLANATION OF PLATE XIII.

Indian and Ceylonese Keratose Sponges.

Spongia officinalis Linn.

FIG. 1. A lamellar form of the sponge viewed from the surface. $\times \frac{2}{3}$.
FIG. 2. A closer view of the surface sponge fibres. $\times 4 \cdot 6$.

Spongia officinalis var. **fenestrata,** nov.

FIG. 3. Viewed from a side. $\times \frac{2}{3}$.
FIG. 4. A closer view of the dermal fibres of the sponge. $\times 4 \cdot 6$.

Spongia officinalis var. **bibulus,** nov.

FIG. 5. Holotype viewed from its surface. $\times \frac{2}{3}$.
FIG. 6. A fragment of the sponge viewed from the side. $\times \frac{2}{3}$.

Hircinia ramodigitata Burton.

FIG. 7. A portion of the colony viewed from the side. $\times 4 \cdot 3$

Hircinia cactiformis, sp. nov.

FIG. 8. Holotype viewed from the side. $\times \frac{2}{3}$.

Hircinia pellita, sp. nov.

FIG. 9. Holotype viewed from its surface. $\times 4 \cdot 3$.

Dysidea herbacea (Keller).

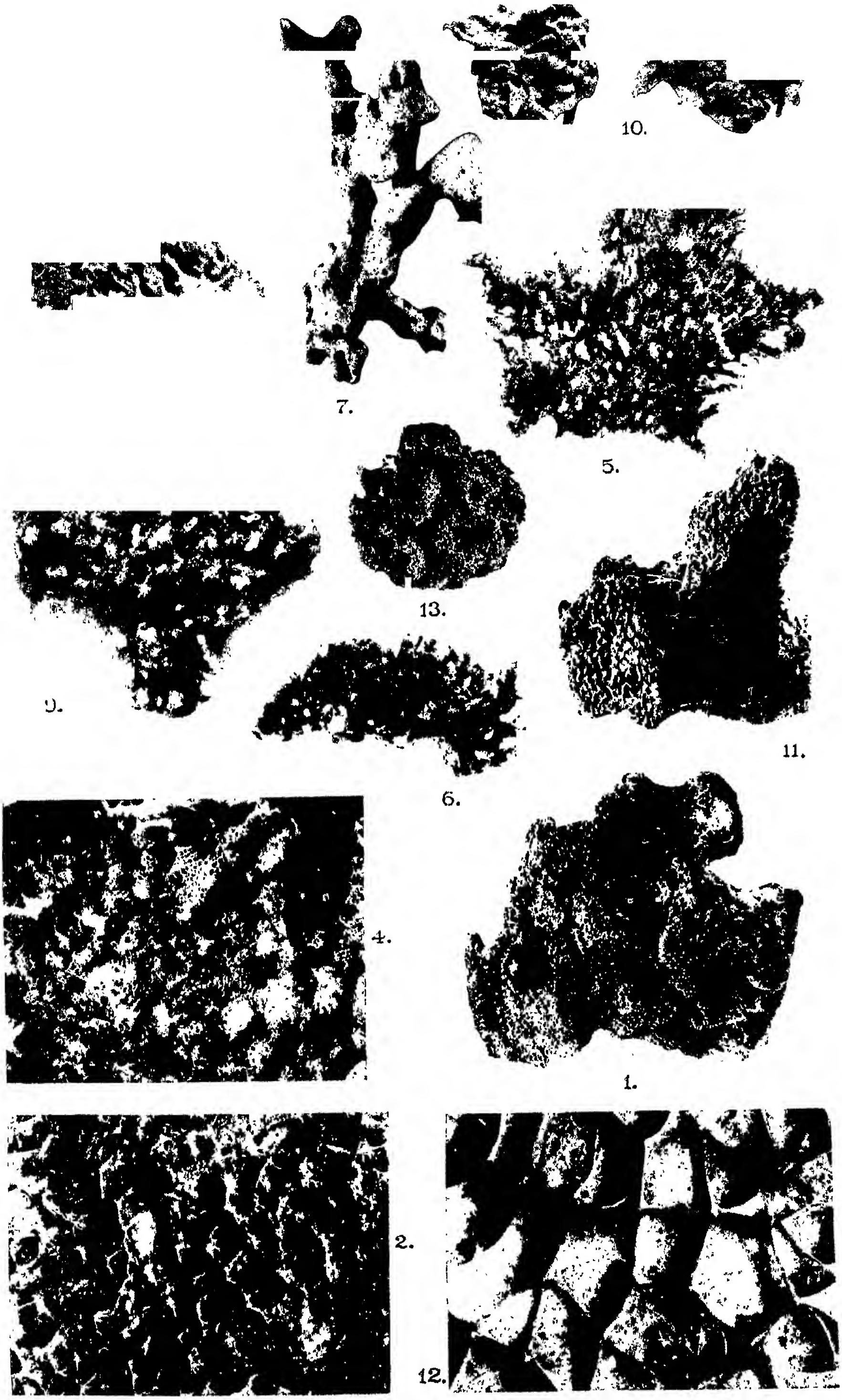
FIG. 10. Two pieces of the sponge growing contiguously on a piece of dead coral. $\times \frac{2}{3}$.

Aplysinopsis reticulata Hentschel.

FIG. 11. A massive specimen viewed from the side. $\times \frac{1}{2}$.
FIG. 12. A closer view of the dermal fibres of the sponge. $\times 4 \cdot 6$.

Spongionella tubulosa Burton.

FIG. 13. A small colony of bulbous tubes of a macerated specimen preserved in alcohol viewed from above. $\times \frac{2}{3}$.



S. C. Mondul, Photo.

Indian and Ceylonese Keratose Sponges.

CYCLOPIDES (CRUSTACÉS COPÉPODES) DE L'INDE. VIII-X.

Par KNUT LINDBERG.

VIII. MEMBRES INDIENS ET IRANIENS DU SOUS-GENRE *CYCLOPS* S. STR. DU GENRE *CYCLOPS* MULLER.

Des représentants du groupe d'animaux, de répartition essentiellement arctique, dont il s'agit ici, n'ont été jusqu' à ce jour signalés que de l'extrême Nord de la péninsule indienne, à Tchitral (Gurney 1906) et dans le Cachemire (Expédition de Yale) de même que dans des régions limitrophes du Thibet (Daday 1908) et dans le Séïstan (Gurney 1920) ainsi que dans d'autres parties de l'Iran. Il est intéressant de relever que parmi les 31 échantillons contenant des Copépodes recoltés par l'Expédition de Yale dans le Cachemire et dans la région frontière du Thibet, il y en avait 10 renfermant des *Cyclops* s. str., 9 d'entre eux ayant été rapportés d'une altitude supérieure à 4000 m. (*C. ladakanus* Kiefer) et un seul d'un lac, situé à 1582 m. au-dessus du niveau de la mer (*C. hutchinsoni* Kiefer). Bien que ces récoltes ont encore été très maigres, par suite du peu d'attention qui a été donnée à la faune aquatique de ces régions, tout porte à croire que dans le Nord de l'Inde, ainsi que dans le Thibet et l'Afghanistan des *Cyclops* s. l. forment un contingent important parmi les Cyclopides habitant les eaux douces et salines de ces contrées, et il semble utile de passer brièvement en revue les espèces du groupe *strenuus* connues actuellement de l'Inde et de l'Iran.

Cyclops strenuus strenuus Fischer.

On ne peut pas encore affirmer d'une façon certaine que l'espèce typique existe vraiment soit aux Indes, soit en Iran. Gurney n'a donné aucune description des animaux de Tchitral et de Zaboul (Nasratabad) et au sujet des individus récoltés à Gyantsé (Thibet), Daday dit seulement, que par suite de la structure de la cinquième patte, ces spécimens semblaient appartenir à la sous-espèce *C. strenuus lacustris* Lilljeborg (=*C. lacustris* Sars).

Cyclops strenuus divergens Lindberg.

Dans plusieurs localités de l'Iran j'ai en 1939-40 retrouvé la forme rencontrée en 1935 et décrite et figurée d'ailleurs d'une façon peu satisfaisante, sous le nom de *Cyclops strenuus divergens*. A cette époque-là je n'avais pas connaissance des articles de Kozminski et je manquais aussi de matériel pouvant servir de comparaison. Les travaux admirables de Kozminski et des autres auteurs polonais ont grandement facilité l'étude des représentants du groupe *strenuus*, et, j'ai maintenant pu constater, que les animaux de l'Iran se rapprochent plus de *C. strenuus*

que de *C. abyssorum* (considéré comme une espèce distincte par Kozminski), ce dernier se distinguant notamment par une plus longue soie apicale interne de la furca. En calculant quelques uns des indices de Kozminski j'ai cependant trouvé que les spécimens de l'Iran s'éloignent assez notablement des caractéristiques données par Kozminski pour *C. strenuus strenuus*, et, je crois utile de maintenir la

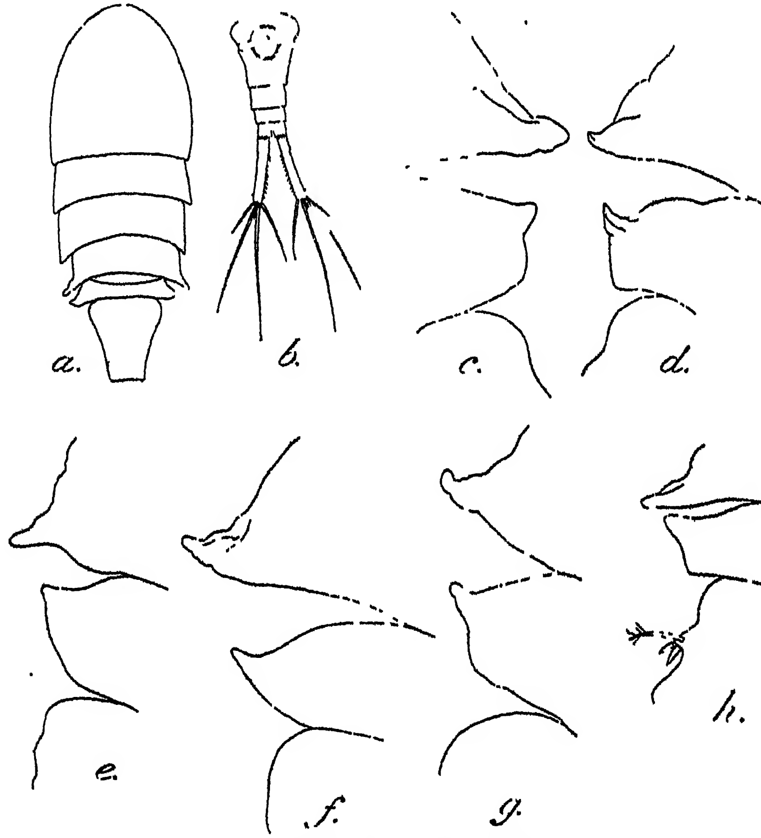


FIG. 1. *Cyclops strenuus divergens* Lindberg.

a. ♀ Céphalothorax et segment génital (Qazvin, bassin mosquée principale) ; *b.* ♀ Abdomen et furca, face ventrale (Qazvin, bassin mosquée principale) ; *c.* ♀ Angles latéraux segments thoraciques 4 et 5 (Qazvin, bassin petite mosquée) ; *d.* ♀ Angles latéraux segments thoraciques 4 et 5 (Chah Abdol Azim, bassin mosquée) ; *e.* ♀ Angles latéraux segments thoraciques 4 et 5 (Chiraz, bassin) ; *f.* ♀ Angles latéraux segments thoraciques 4 et 5 (Khorramchahr, bras-mort de canal d'irrigation) ; *g.* ♀ Angles latéraux segments thoraciques 4 et 5 (Khorramchahr, fosse) ; *h.* ♀ Angles latéraux segments thoraciques 4 et 5 et P 6 (Keredj, mare).

séparation de la sous-espèce *divergens* jusqu'au jour qu'il sera possible d'entreprendre une étude morphométrique sur un matériel suffisant. En attendant la solution de la question je me borne à donner ici quleques mensurations et des figures. La distance de la base de la furca jusqu'à l'insertion de la soie latérale externe en pourcentage de la longueur de la branche de la furca et le même pourcentage de la longueur de

la soie dorsale ont été mentionnés, ces deux caractéristiques semblant avoir une valeur diagnostique indiscutable.

La première antenne, toujours de 17 articles, atteignait, lors qu'elle était rabattue, le bord postérieur du premier segment céphalo-thoracique ou le millieu du deuxième segment thoracique chez la plupart des femelles adultes examinées. Le nombre des oeufs furent comptés dans un ovisac

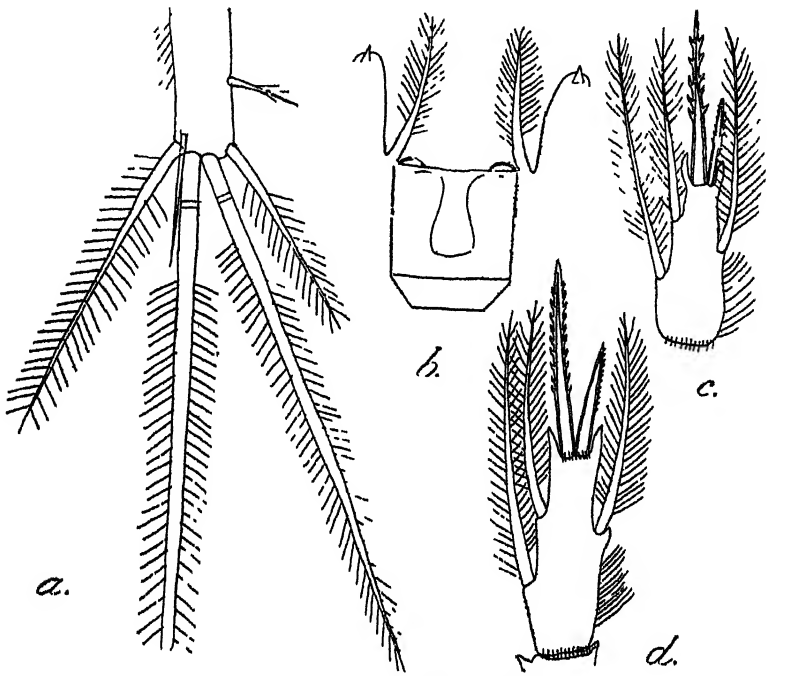


FIG. 2. *Cyclops strenuus divergens* Lindberg.

a. ♀ Extrémité d'une branche de la furca (Qazvin, bassin mosquée principale) ; *b.* ♀ Lamelle basale de P 4 (Qazvin, bassin mosquée principale) ; *c.* ♀ Article 3 de l'enp. 4 (Qazvin, bassin mosquée principale) ; *d.* ♀ Article 3 de l'enp. 4 (Qazvin, bassin petite mosquée).

chez 10 femelles ; le plus petit nombre était de 38 et le plus grand 104 ; le chiffre moyen obtenu était de 69·6 oeufs dans un sac.

A propos de la distinction de *C. strenuus* s. l. de *C. scutifer* Sars, en considérant seulement l'élargissement des angles latéraux du quatrième et du cinquième segments thoraciques, il convient de remarquer, qu'une telle distinction est, dans le cas de *C. strenuus divergens*, souvent très malaisée, par suite de l'élongation et l'élargissement considérable que présentent ces parties chez bien de spécimens iraniens.

Habitats.---Plateau : Broudjerd, 3 citernes, sept. 1935 ; Chah Abdol Azım, bassin nov. 1939; Chiraz, citerne souterraine, oct. 1935, 2 bassins, mars 1940 ; Isfahan 2 puits, sept. 1935 ; Keredj, mare, jan. 1940 ; Qazvin, 4 bassins, nov. 1939 ; Qoum, 2 citernes, sept. 1939 ; Réy, bras-mort d'un canal, nov. 1939 ; Téhéran, bassin, nov. 1939.

Provinces Caspiennes : Pahlévi, Mourd-ab (grande lagune) nov. 1939,

Khouzistan : Chouchter, rivière Minaou (Mianab), jan. 1940 : Khorramchahr, petit marécage, petite mare, fosse, bras-morts de canaux d'irrigation dans plantations de dattiers (deux localités) jan. 1940.

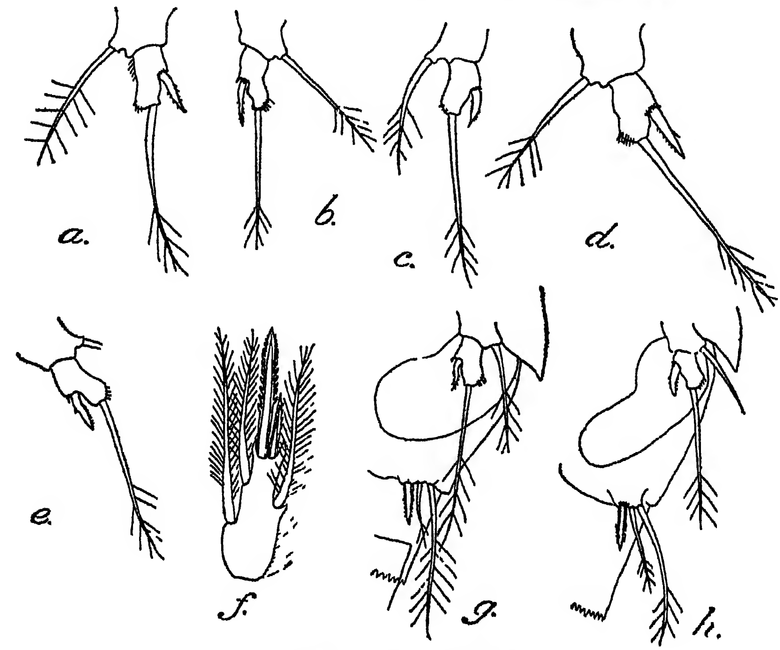


FIG. 3. *Cyclops strenuus divergens* Lindberg.

a. ♀ P5 (Qazvin, bassin petite mosquée) ; *b.* ♀ P5 (Chah Abdol Azim, bassin mosquée) ; *c.* ♀ P5 (Chiraz, bassin) ; *d.* ♀ P5 (Chouchter, rivière) ; *e.* ♀ P5 (Khorramchahr, petite mare) ; *f.* ♂ Article 3 de l'enp. 4 (Khorramchahr, petite mare) ; *g.* ♂ P 5 et P 6 (Qazvin, bassin mosquée du Roi) ; *h.* ♂ P5 et P 6 (Khorramchahr, petite mare).

La répartition des animaux trouvés dans les habitats divers est montrée ci-dessous.

Bassins (Haouz)	8
Citernes (Ab-ambar)	6
Bras-morts de canaux	3
Fosse	1
Puits	2
Mares	2
Marécage	1
Rivière	1
Lagune	1

Tous ces biotopes, sauf les trois derniers, étaient de caractère oligotrophique et ne montraient presque pas de végétation macroscopique ; la nature temporaire ou semi-permanente de 6 d'entre eux était évidente. Les puits à Isfahan avaient une profondeur d'environ 1 mètre et la surface de l'eau se trouvait près du niveau du sol au moment de ma visite. Dans la petite rivière à Chouchter une seule femelle fut récoltée et un mâle unique dans la lagune à Pahlévi ; celui-ci semblait appartenir à la même espèce. Une seule femelle, en compagnie de nombreux *E. serrulatus*

(Fisch.) fut pêchée à Keredj, dans une petite mare dépourvue de végétation, à fond d'épaisses couches de feuilles décomposées.

Les animaux étaient particulièrement nombreux dans les bassins et les citernes, dont certaines, telles que celles de Qoum contenaient de l'eau saumâtre.

Cyclops ladakanus Kiefer.

Forme ressemblant beaucoup à *C. strenuus* mais s'en distinguant notamment par la formule des épines qui est de 2-4-3-3. Branches de la furca presque parallèles, de 5 à 6 fois aussi longues que larges. Première antenne à 17 articles. P 5 à épine très courte. Rapporté aux mois d'août et septembre 1932 par l'Expédition de Yale de 8 lacs, apparemment tous à l'eau saumâtre, et d'une petite mare, de la région frontière indo-thibétaine, dans le Ladak et du côté de Roupchou.

Cyclops hutchinsoni Kiefer.

Espèce décrite d'après un seul spécimen, mais semblant avoir des caractéristiques assez bien définies. Furca à branches divergentes de 7·7 fois aussi longues que larges. Soie dorsale plus longue que la soie apicale externe de la furca. Soie apicale interne plus de deux fois aussi longue que la soie apicale externe. Première antenne à 16 articles. Segment génital se rétrécissant graduellement d'avant en arrière. Formule des épines 2-3-3-3.

Récolté en avril par l'Expédition de Yale dans un lac, probablement à l'eau douce, à Srinagar (Cachemire).

Mon assistant, le medecin indigène Dr. George Daniel, a en janvier 1937 rapporté d'un étang artificial à Landi Kotal, près de la frontière indo-afghane, une femelle unique en fort mauvais état. Pour autant que j'ai pu l'examiner je me crois justifié à l'identifier avec l'animal de Srinagar, décrit par Kiefer. Je donne ci-dessous quelques notes et les mensurations qu'il a été possible de faire.

Longueur (sans soies apicales) 1767 μ ; céphalothorax 1102 μ, queue 665 μ ; largeur maximum 598 μ. Angles latéraux des bords postérieurs du quatrième et cinquième segments thoraciques peu prolongés et sans expansions aliformes. Furca à branches fortement divergentes, à bord interne cilié et portant une crête chitineuse sur la face dorsale. Longueur : largeur (233+42) : 37 μ=7·43 : 1. Soie dorsale 125 μ. Soie apicale externe 140 μ. Soie apicale interne 300 μ. La première antenne atteignait lorsqu'elle était rabattue le bord antérieur du deuxième segment thoracique. Elle semblait composée de 16 articles ; Sa longueur totale était de 785 μ. Formule des épines 2-3-3-3. Article 3 de l'enp. 4, longueur : largeur 115 : 45=2·56 : 1 ; épine apicale interne : épine apicale externe 117 : 53=2·21 : 1. P 5 à épine inséréé un peu au-delà du milieu du rebord interne de l'article 2; elle était remarquablement forte et courte étant seulement 5 fois plus longue que large. Article 2, longueur : largeur 37: 18·5 μ=2 : 1; épine 25 μ, soie apicale 117 μ, soie du premier article 77 μ. Le réceptacle séminal n'a pas pu être distingué. L'animal ne possédait pas de sacs ovigères.

Cyclops caspicus Lindberg.

Espèce se rapprochant à la fois de *C. vicinus* Uljanine et de *C. furcifer* Claus: se distinguant de ce dernier par une structure différente des angles latéraux des bords postérieurs des segments thoraciques 4 et 5, et par des branches de la furca plus courtes. Première antenne à nombre d'articles variable, de 14, 16 ou 17.

Habitat.—Bender Gaz (Gorgan) marais, mare, marécage.

Cyclops kozminskii Lindberg.

Forme très aberrante. Branches de la furca environ 6 fois aussi longues que larges. Première antenne à 17 articles. Formule des épines 2-3-3-3. Epines apicales de l'article 3 de l'enp. 4 de longueur sensiblement égale. Réceptacle séminal ressemblant à celui de *C. insignis* Claus.

Habitat.—Une fosse à Lahidjan (Guilan).

Cyclops vicinus vicinus Uljanine.

Récolté par l'Expédition de Yale en avril 1932 dans le plancton de deux lacs dans le Cachemire à une altitude de 1581 mètres. (Kiefer 1939). Déjà connu de l'Iran, où Tatnogradsky l'avait trouvé au mois de décembre à Pahlévi (Enzéli) port de la Caspienne à 26 mètres au-dessous du niveau de la mer (Rylov 1928).

Je n'ai pas retrouvé cette espèce au cours de mes pêches en Iran.

Clef de détermination.

1. Formule des épines 3-4-3-3	*C. strenuus divergens.* Iran.
Formule des épines 2-4-3-3	*C. ladakanus.* Inde (Cachemire). Thibet.
Formule des épines 2-3-3-3	2
2. Angles latéraux des bords postérieurs des segments thoraciques 4 et 5 ne montrant pas d' expansion aliforme évidente	3
Ces parties montrant une expansion aliforme évidente ou un élargissement notable	4
3. Epine apicale interne de l'article 3 de l'enp. 4 plus de 2 fois aussi longue que l'épine apicale externe	*C. hutchinsoni.* Inde (Cachemire, Province de la frontière Nord-Ouest).
Epines apicales de l'article 3 de l'enp. 4 de longueur à peu près égale	*C. kozminskii.* Iran.
4. Segment génital à constriction brusque vers le milieu	*C. caspicus.* Iran.
Segment génital se rétrécissant graduellement d'avant en arrière	*C. vicinus.* Inde (Cachemire). Iran.

RÉSUMÉ.

Six espèces du groupe *strenuus* sont actuellement connues de l'Inde et de l'Iran. Leurs caractéristiques principales ont été récapitulées et une clef de détermination donnée.

IX. CONTRIBUTION À LA CONNAISSANCE DES GENRES *PARACYCLOPS* CLAUS ET *ECTOCYCLOPS* BRADY.

Genre **Paracyclops** Claus.

En étudiant il y a quelques années des *Paracyclops* de provenance indienne je me suis aperçu qu'ils différaient dans quelques particularités de *P. fimbriatus* (Fischer), tel qu'il a été décrit en Europe. La rangée de petites épines près de l'insertion de la soie latérale externe sur la face dorsale de la furca ne s'arrêtait pas sur le milieu de la branche, mais continuait transversalement jusqu' à son rebord interne ; de plus, les spécimens indiens présentaient tous une épine de la cinquième patte mince et allongée, au lieu de l'épine courte et forte des animaux européens. Une troisième particularité de ces individus était une soie médiane de la sixième patte du mâle peu développée, beaucoup plus courte que la soie externe de cette patte rudimentaire. J'ai cru devoir séparer ces animaux comme appartenant à une espèce distincte que j'ai nommée *P. vagus*.

Les récoltes faites dans l'Iran m'ont rapporté des *Paracyclops* d'un total de 9 localités, représentant 13 habitats différents. Un certain nombre d'entre eux répondait aux caractéristiques de *P. fimbriatus*

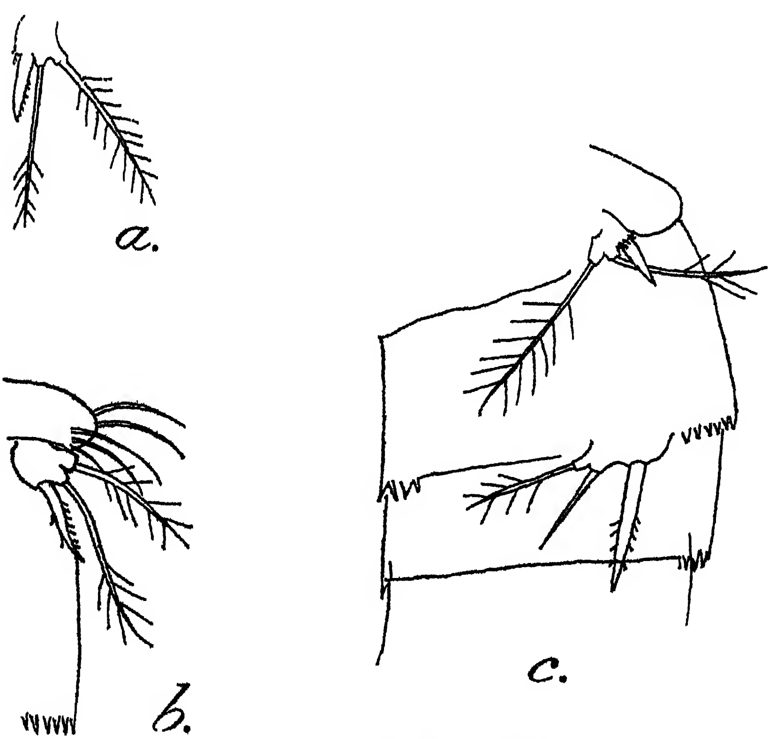


FIG. 4. *Paracyclops fimbriatus* (Fischer).
a. ♀ P5 (Pasghaléh) ; *b.* ♀ P5 (Isfahan) ; *c.* ♂ P5 et P 6 (Dizfoul).

d'autres à celles de *P. vagus*. Ces derniers montraient une rangée d'épines de la face dorsale de la furca s'étendant jusqu' au rebord interne

et une épine de P 5 longue et mince; la soie médiane de P 6 du mâle était cependant chez deux des trois animaux examinés un peu mieux développée que chez les exemplaires indiens, et il est possible que cette dernière caractéristique n'ait pas de valeur diagnostique absolue. Il faut dire aussi, que l'un des animaux, chez lesquels les épines de la furca s'arrêtaient au milieu de la branche, présentait une épine de P 5 de

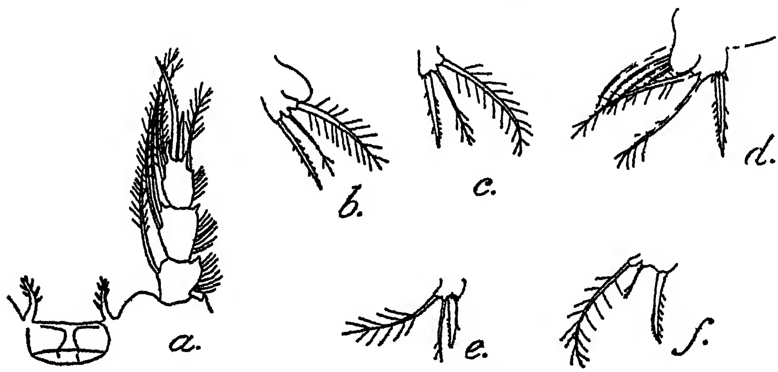


FIG. 5. *Paracyclops vagus* Lindberg.

a. ♀ Lamelle basale et endopodite de P 4 (Chahi, fosse); *b.* ♀ P5 (Chahi, fosse); *c.* ♀ P5 (Chahi, mare); *d.* ♀ P5 (Ramsar); *e.* ♂ P5 (Chahi mare); *f.* ♂ P6 (Chahi, mare).

longueur inusite, mais comme cette épine était cependant forte et élargie elle retenait à un certain degré l'aspect caractéristique de cette épine chez *P. fimbriatus*. Des individus des deux types ne se trouvaient nulle part ensemble dans un même habitat.

La première antenne était chez tous les animaux formée de 8 articles et leur longueur relative différait peu entre les représentants des deux types, les plus longs étaient toujours les articles I et IV, ensuite venaient les articles VIII et VII et les articles III et VI étaient les plus courts. Trois femelles de chaque espèce portaient des ovisacs, renfermant de 4 à 10 oeufs chez les deux types.

Tous les animaux répondant à l'espèce *P. vagus* avaient les branches de la furca bien séparées à leur base, le rapport entre la longueur et la largeur variant de 4·68 : 1 à 6·14 : 1. Trois des individus qui manifestement appartenaient à l'espèce typique *P. fimbriatus* présentaient une furca à branches très rapprochées à la base (celui de Dizfoul et les deux spécimens d'Isfahan), mais deux d'entre eux ayant une furca de 4 ou plus de 4 fois aussi longue que large et les soies et l'épine de P 5 de longueur fort inégale, il n'a pas été possible de les référer à la forme *P. finitimus* Kiefer. Du reste Kiefer a lui-même en 1934 exprimé des doutes sur la validité comme espèces distinctes d'aussi bien de *P. finitimus* que de *P. abnobensis* Kiefer. Pour autant que j'ai pu me rendre compte il n'y a aucune justification à séparer des formes distinctes d'après seulement la longueur et le degré de rapprochement des branches de la furca. Il faut dire aussi que des études d'un matériel beaucoup plus abondant sont nécessaires pour pouvoir se prononcer définitivement sur la signification de *P vagus* en tant qu'espèce distincte de *P. fimbriatus*. D'une façon générale l'examen des animaux iraniens a corroboré cette distinction.

Genre **Ectocyclops** Brady.

En 1939 j'avais l'occasion d'examiner une quarantaine de spécimens du genre *Ectocyclops* provenant de régions diverses de la péninsule indienne. J'ai pu les référer tous à l'espèce *E. rubescens* Brady (syn. *E. medius* Kiefer) la première antenne de la femelle étant formée de 11 articles et l'épine interne de la cinquième patte considérablement plus longue que

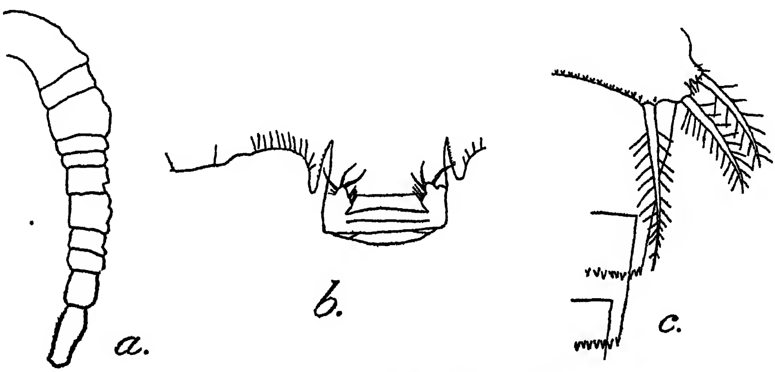


FIG. 6. *Ectocyclops rubescens* Brady ♀ (Chahi).
a. Première antenne ; *b.* Lamelle basale de P 4 ; *c.* P 5.

les deux autres appendices de cette patte, et atteignant en général le bord postérieur du segment génital. Aucun membre du genre en question ayant jusqu'ici été rapporté de l'Iran. il est intéressant de pouvoir faire connaître maintenant quelles espèces en sont les représentants dans ce pays et de donner une indication de leur répartition.

Du total de 249 échantillons (105 du Nord, 144 du Sud) contenant des Cyclopides collectionnés pendant l'hiver 1939-40 des *Ectocyclops* ne se sont trouvés que dans 10, provenant de 6 localités différentes, 3 du Nord et 3 du Sud. Ces récoltes représentaient 6 habitats du Nord et 4 du Sud, les animaux étant considérablement plus nombreux dans les premiers.

Avec une seule exception il s'agissait de spécimens de *E. rubescens* Brady, différant légèrement des animaux de l'Inde. Dans un étang d'eau douce à Baba Hadji, au sud de Chiraz, j'ai trouvé quelques *Ectocyclops* manifestement identiques au *E. phaleratus* Koch. Quatre des *E. rubescens* portaient des sacs ovigères. Les ovisacs de la femelle la plus grande du marécage à Suse renfermaient 10 et 12 oeufs ; le nombre des oeufs chez les autres variaient de 5 à 7.

Des mensurations et quelques figures sont données ici de ces individus.

X. UNE REVISION DES REPRÉSENTANTS INDIENS ET IRANIENS DES SOUS-GENRES *ACANTHOCYCLOPS* KIEFER ET *DIACYCLOPS* KIEFER.

Les animaux appartenant aux sous-genres *Acanthocyclops* et *Diacyclops*, distingués par Kiefer, mais de parentage apparemment très étroit, ont une répartition surtout arctique. Quelques uns d'entre eux ayant aussi été signalés dans des régions tropicales, il est intéressant de récapituler ce qui est actuellement connu de leur présence dans l'Inde et dans l'Iran.

Cyclops (Acanthocyclops) vernalis Fischer.

Kiefer a montré que les animaux provenant du Point de Galle, identifiés par Poppe et Mrazek comme *C. vernalis*, sont en réalité des spécimens de *C. robustus* Sars. Pour autant que je le sache aucune de ces deux espèces n'a jamais été trouvée dans la péninsule indienne, En 1921 le *C. vernalis* a été rapporté de Recht (Guilan) par le Dr. Buxton.

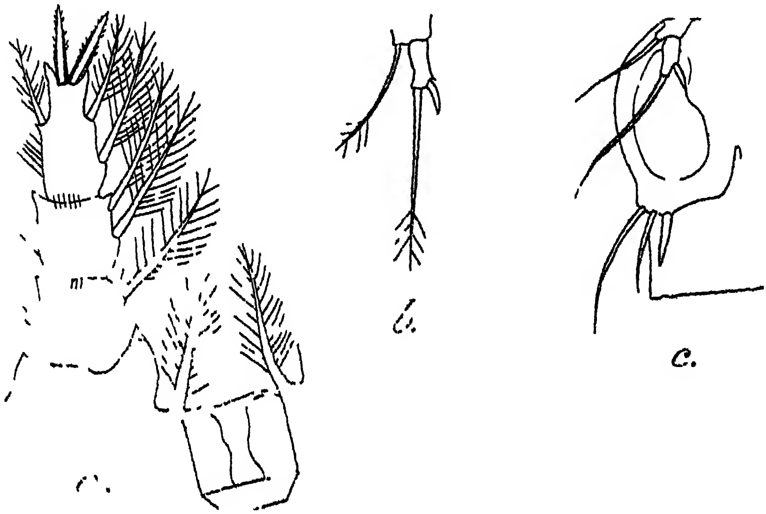


FIG. 7. *Cyclops (Acanthocyclops) vernalis* Fischer.

a. ♀ Endopodite de P 4 et lamelle basale (Lahidjan) ; *b.* ♀ P5 (Lahidjan) ; *c.* ♂ P5 et P 6 (Recht).

et en 1939 je l'ai retrouvé à ce même endroit et dans 4 autres localités des provinces Caspiennes. Je ne l'ai rencontré nulle part ailleurs en Iran.

La formule des épines était de 2-3-3-3 chez tous les échantillons examinés ; je n'ai pas observé des soies transformées en épines aux pattes natatoires. Le plus grand nombre d'oeufs comptés dans un ovisac était de 76.

Habitats.—Provinces Caspiennes :

Bender Gaz, rivière ; Lahidjan, fosses (2), marais ; Pahlévi-Ghazian, puits : Ramsar, mare ; Recht, fosses (3).

Cyclops (Acanthocyclops) robustus Sars.

Celui-ci se différencie de l'espèce précédante par la formule des épines qui est de 3-4-4-4, et par une structure différente de P 5, dont le premier article est plus élargi et le deuxième article plus trapu que chez *C. vernalis.*

Chez un spécimen l'article 3 de l'exopodite de P 4 portait d'un côté 5 épines, tandis que l'autre patte avait le nombre normal d'épines. Je n'ai vu des soies transformées en épines chez aucun animal examiné. L'article 3 de l'enp. 4 présentait chez un individu une particularité tératologique, une épine bien dévelopée se trouvant un peu en dedans et au même niveau que la soie du rebord externe. J'ai compté 102 oeufs dans un ovisac.

Habitats.—Ceylan :—Point de Galle, étang d'eau douce (Poppe et Mrazek 1895).

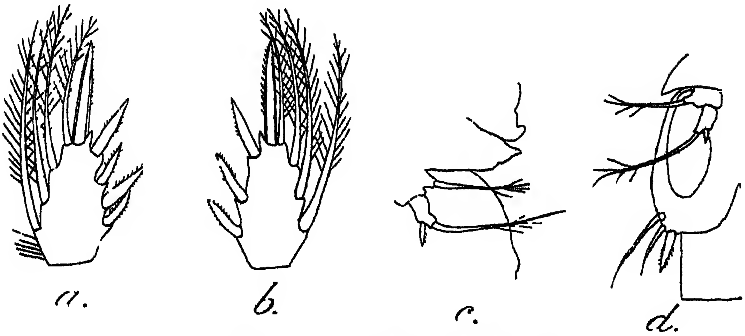


FIG. 8. *Cyclops (Acanthocyclops) robustus* Sars.

a. Article 3 de l'exopodite de P 4 côté gauche, tératologique, à 5 épines ; *b*. ♀ Do. côté droit, normal, à 4 épines (Pahlévi-Ghazian) ; *c*. ♀ Angles latéraux des quatrième et cinquième segments thoraciques et P 5 (Pahlévi-Ghazian) ; *d*. ♂ P5 et P 6 (Pahlévi-Ghazian).

Provinces Caspiennes :- Ramsar, mare, marécage ; Recht, ruisseau ; Pahlévi-Ghazian, puits, mares (2).

Cyclops (Diacyclops) bicuspidatus Claus.

Jamais rapporté de l'Inde pour autant qu'il me soit connu. Très commun dans le Nord de l'Iran et apparemment rare dans le Sud.

Habitats. Provinces Caspiennes et plateau :—

Astanéh, bassin ; Babol, puits ; Bender Chah, mare au bord de la mer ; Bender Gaz, mare près de la voie ferrée ; Chahi, fosse, mare ;

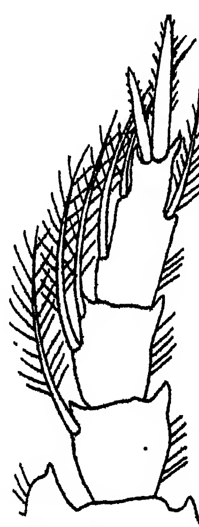


FIG. 9. *Cyclops (Diacyclops) bicuspidatus* Claus. ♂ Endopodite de P 4 (Ramsar).

Derbend mare de rivière ; Gorgan, mare d'une four à briques ; Kalatchayéh, mare ; Lahidjan, petite rivière, fosses (2), marais, puits

étang, rizière ; Langueroud, puits, mare ; Méchhed, bassin (nov. 1935) ; Pahlévi, puits ;Pahlévi-Gazian, puits ; Qoum, citerne (sept. 1935) ; Qazvin, bassins (3) ; Ramsar, petit étang, marécage ; Recht, puits mares (3), fosses (2), bassin.

Sud :—Khorramchahr, bras-mort d'un canal d'irrigation de plantation de dattiers.

Cyclops (Diacyclops) bicuspidatus odessanus Chmankevitch.

A l'encontre de la forme précédante cette sous-espèce ou variété semble commune dans le Sud-Ouest de l'Iran et assez peu fréquente dans le Nord.

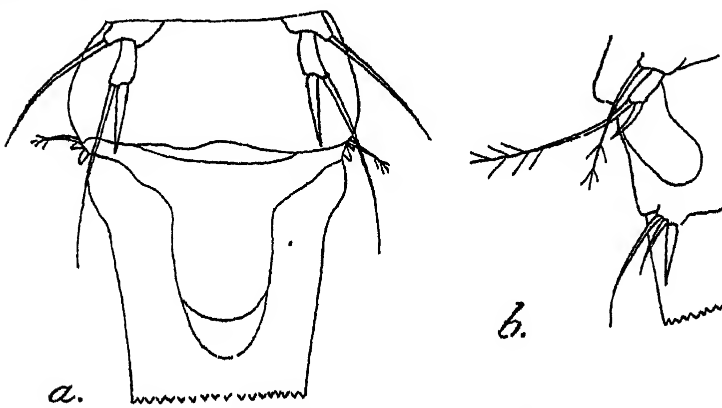


Fig 10. *Cyclops (Diacyclops) bicuspidatus odessanus* Chmankevitch.
a. ♀ Segment genital et P 5 (Khorramchahr) ; *b.* ♂ P 5 et P 6 (Khorramchahr).

Habitats.—Provinces Caspiennes et plateau :—

Bender Gaz, marécage entre la ville et la mer, marais au bord de la mer ; Qoum, citerne (sept. 1935).

Sud :—Abadan, fosse dans plantation de dattiers ; Ahvaz, marécages (2), petit étang Béhbéhan puits ; Bouchir, fosse sur la route à Tchaghadak ; Darquoin, fosse ; Khorramchahr, petit marécage, petite mare ; Marghazar, fosse ; Tchaghadak, fosse.

Cyclops (Diacyclops) bisetosus Rehberg.

Espèce à vaste aire de répartition et très adaptable à des milieux différents, elle n'a pourtant pas encore été trouvée dans l'Inde. Très commune dans le Nord de l'Iran, elle se rencontre aussi dans les régions torrides du Sud.

Habitats.—Provinces Caspiennes et plateau :—

Baqirabad, étang ; Bender Gaz, mare près de la voie ferrée ; Chahi, fosses (2) ; Gorgan, petite mare, fosse ; Isfahan, puits ; Kalatchayéh, petit étang au bord de la mer ; Lahidjan, rizière, mare ; Pahlévi, mares

(2), lagune ; Pahlévi-Ghazian, mare ; Ramsar, mare d'un torrent, trou d'eau, marais, petit étang, mare, marécage ; Recht, ruisseau.

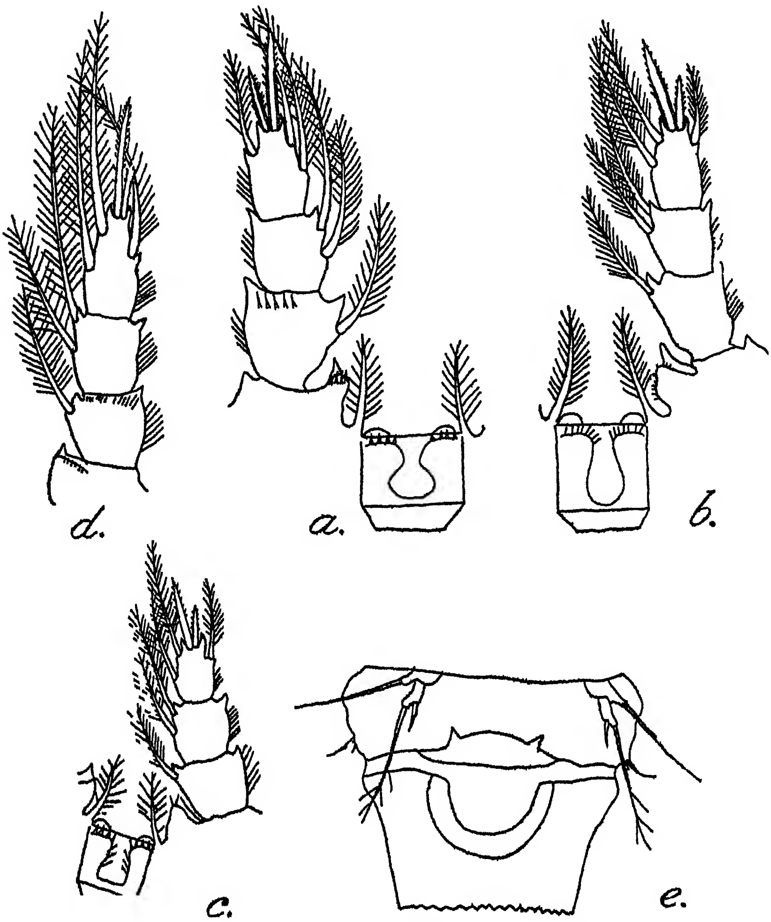


FIG. 11. *Cyclops* (*Diacyclops*) *bisetosus* Rehberg.

a. ♀ Endopodite de P 4 et lamelle basale (Ramsar) ; *b.* ♀ Do. (Pahlévi, lagune) ; *c.* ♀ Do. (Pahlévi mare) ; *d.* ♀ Endopodite de P 4 (Tchabadi) ; *e.* ♀ Segment génital et P 5 (Pahlévi, lagune).

Sud : - Ahvaz, étang ; Khorramchahr, bras-mort d'un canal d'irrigation ; Tchabadi (5 kilomètres au sud de Hadakou), marais.

Cyclops (Diacyclops) alticola Kiefer.

Forme pêchée par l'Expédition de Yale dans des mares et des lacs peu profonds de 4 localités de la région frontière indo-thibétaine, à une altitude variant de 4252 m. à 5217 m. au-dessus du niveau de la mer. Pour autant qu' on peut se rendre compte d'après la description et les figures de Kiefer elle semble identique à *C. bicuspidatus* mais la première antenne ne compte que 12 articles, au lieu de 17 ; que cela soit en fonction de conditions écologiques particulières ou non, on ne peut naturellement rien en dire à l'état actuel de nos connaissances.

Habitats.—Cachemire (Ladak); -Lac Tsar entre Mougleb et lac Panggong; Tchagra, Nord-Ouest de lac Panggong, mares dans un terrain marécageux; lac Togarma, Nord-Ouest de lac Panggong, petite mare.

Thibet :—Lac Nyak.

Cyclops (Diacyclops) languidus Sars.

Rapporté par Daday du Ceylan en 1898. Kiefer a en 1928 émis des doutes sur cette diagnose, disant que Daday n'a pas donné de description des animaux examinés.

Habitats.—Ceylan :—Marais de Madatugama et des environs du lac Kalaveva.

RÉSUMÉ.

Sept formes des sous-genres *Acanthocyclops* Kiefer et *Diacyclops* Kiefer sont actuellement connues de l'Inde (y compris le Cachemire et le Ceylan) et de l'Iran. La présence de l'une d'entre elles n'a pas encore été confirmée.

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[1] L'ouvrage marqué (*) n'a pas été consulaté dans l'original.

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Cyclops strenuus divergens Lindberg ♀.

Localité	Longueur µ	Furca	Insertion soie lat. ext. p. cent long. furca	Soie dors.	Soie dors. p. cent. long. furca	Soie ap. int. : soie ap. ext.	Enp. 4. Art. 3 Long. : large.	Enp. 4. Art. 3 Ep. ap. int. : ép. ap. ext.	Enp. 4 Long. art. 3. : ép ap. int.	Formule des épines
Qazvin.										
Bassin, mosquée principale.	2099	(222+52) : 47=5·83 : 1	81	112	40·9	225 : 145=1·55 : 1	118 : 50=2·36 : 1	110 : 57=1·93 : 1	1·07 : 1	3-4-3-3
Bassin, mosquée du Roi.	1900	(230+47) : 38=7·29 : 1	83	103	37·2	239 : 133=1·79 : 1	110 : 37=2·97 : 1	95 : 50=1·90 : 1	1·16 : 1	3-4-3-3
Bassin, petite mosquée.	2346	(318+58) : 48=7·73 : 1	85·7	133	35·8	317 : 175=1·81 : 1	153 : 57=2·68 : 1	122 : 78=1·56 : 1	1·25 : 1	3-4-3-3
Chah Abdol Azim	1995	(246+53) : 40=7·47 : 1	82·3	103	34·4	X : 135=X : 1	117 : 52=2·25 : 1	100 : 53=1·89 : 1	1·17 : 1	3-4-3-3
Bassin.	1929	(241+53) : 45=6·53 : 1	81·9	110	37·4	275 : 133=2·07 : 1	117 : 50=2·34 : 1	102 : 52=1·96 : 1	1·15 : 1	3-4-3-3
Rèy.										
Bras-mort d'un canal.	2023	(235+57) : 47=6·21 : 1	80·5	122	41·7	264 : 150=1·76 : 1	123 : 50=2·46 : 1	108 : 67=1·61 : 1	1·14 : 1	3-4-3-3
Keredj Mare.	1729	(239+53) : 38=7·68 : 1	81·8	113	35·7	254 : 133=1·91 : 1	108 : 42=2·57 : 1	110 : 61=1·80 : 1	0·98 : 1	3-4-3-3
Isfahan Puits.	2090	(205+47) : 45=5·60 : 1	81·3	..	..	257 : 138=1·86 : 1	117 : 45=2·60 : 1	109 : 57=1·91 : 1	1·08 : 1	3-4-3-3
Broudjerd Citerne.	1934	(216+53) : 38=7·08 : 1	80·3	105	39	208 : 113=1·84 : 1	103 : 44=2·34 : 1	100 : 51=1·96 : 1	1·03 : 1	3-4-3-3
Chiraz.	2223	(235+52) : 45=6·38 : 1	81·9	117	40·8	262 : 150=1·75 : 1	125 : 55=2·27 : 1	117 : 62=1·89 : 1	1·07 : 1	3-4-3-3
Bassin.	2309	(261+58) : 45=7·09 : 1	81·8	..	..	275 : 175=1·57 : 1	130 : 45=2·89 : 1	117 : 73=1·60 : 1	1·11 : 1	3-4-3-3
Chouchter Rivière.	2318	(291+58) : 50=6·88 : 1	84·6	117	34	284 : 167=1·70 : 1	133 : 55=2·42 : 1	110 : 65=1·69 : 1	1·21 : 1	3-4-3-3
Khorramchahr Petit marécage.	2360	(287+58) : 50=6·90 : 1	83·2	125	36·2	267 : 150=1·78 : 1	122 : 55=2·22 : 1	108 : 58=1·86 : 1	1·13 : 1	3-4-3-3
Bras-mort de canal d'irrigation.	2289	(283+52) : 48=6·93 : 1	84·5	125	37·3	304 : 184=1·65 : 1	133 : 52=2·56 : 1	118 : 60=1·97 : 1	1·13 : 1	3-4-3-3 3-3-3-3
Autre bras-mort.	2327	284+47=6·04 : 1	..	127	42·3	250 : 150=1·67 : 1	114 : 50=2·28 : 1	117 : 68=1·72 : 1	0·97 : 1	3-4-3-3
Fosse.	2099	(230+47) : 43=6·44 : 1	83	160	38·1	259 : 133=1·83 : 1	107 : 49=2·18 : 1	97 : 52=1·87 : 1	1·10 : 1	3-4-3-3

Cyclops strenuus divergens Lindberg ♂.

Localité	Longueur µ	Furca	Soie dors.	Soie ap. int. : soie ap. ext.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ép. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ép. ap. int.	P. 6 Epine : soie méd. : soie ext.
Qazvin								
Bassin, mosquée principale.	1592	(149+40) : 38=4·97 : 1	122	227 : 117=1·94 : 1	98 : 39=2·51 : 1	110 : 58=1·89 : 1	0·89 : 1	33 : 53 : 117
Bassin, mosquée du Roi.	1535	(155+42) : 37=5·32 : 1	133	250 : 127=1·97 : 1	100 : 36=2·78 : 1	102 : 53=1·92 : 1	0·98 : 1	33 : 55 : 113
Bassin, petite mosquée.	1710	209+37=5·65 : 1	..	227 : 120=1·89 : 1	....	....	....	42 : 67 : 142
Chah Abdol Azim Bassin.	1581	(162+48) : 38=5·26 : 1	133	234 : 130=1·80 : 1	100 : 37=2·70 : 1	105 : 50=2·10 : 1	0·95 : 1	33 : 55 : 97
Réy								
Bras-mort d'un canal.	1577	199+42=4·74 : 1	142	234 : 112=2·09 : 1	105 : 45=2·33 : 1	112 : 63=1·78 : 1	0·94 : 1	32 : 53 : 107
Broudjerd Citerne.	1435	(119+38) : 32=4·90 : 1	108	189 : 98=1·93 : 1	90 : 33=2·73 : 1	98 : 50=1·96 : 1	0·92 : 1	32 : 47 : 97
Chiraz Bassin.	1814	(177+42) : 37=5·92 : 1	142	234 : 137=1·70 : 1	110 : 40=2·75 : 1	117 : 70=1·67 : 1	0·94 : 1	32 : 58 : 117
Khorramchahr								
Petit marécage.	1644	(126+47) : 33=5·24 : 1	113	220 : 123=1·79 : 1	100 : 42=2·38 : 1	110 : 57=1·93 : 1	0·91 : 1	30 : 50 : 100
Bras-mort de canal d'irrigation.	1548	(157+47) : 38=5·37 : 1	140	240 : 133=1·80 : 1	97 : 42=2·31 : 1	117 : 67=1·75 : 1	0·88 : 1	37 : 67 : 125
Autre bras-mort.	1672	(158+42) : 37=5·40 : 1	138	242 : 143=1·69 : 1	102 : 40=2·55 : 1	100 : 57=1·75 : 1	1·02 : 1	32 : 58 : 108
Fosse.	1748	(178+42) : 33=6·67 : 1	133	239 : 133=1·79 : 1	95 : 40=2·37 : 1	105 : 50=2·10 : 1	0·90 : 1	33 : 55 : 107
Petite mare.	1539	(164+38) : 33=6·12 : 1	125	234 : 125=1·87 : 1	95 : 37=2·57 : 1	103 : 52=1·98 : 1	0·92 : 1	33 : 60 : 112
Pahlévi								
Mourd-ab.	1463	(135+40) : 32=5·47 : 1	120	207 : 108=1·92 : 1	93 : 32=2·91 : 1	110 : 62=1·77 : 1	0·84 : 1	33 : 58 : 123

Paracyclops fimbriatus Fischer ♀.

Localité	Longueur µ	Furca	Soie dorsale	Soies apicales	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ép. ap. int.	P. 5 Epine : soie méd. : soie ext.	P. 6 Epine : soie méd. : soie ext.
Darquoin Fosse.	912	117 : 23=5·09 : 1	63	68 : 219 : 406 : 83	45 : 20=2·25 : 1	77 : 35=2·22 : 1	0·58 : 1	50 : 58 : 80 (forte)	
Dizfoul Mare souterraine	760	92 : 23=4 : 1	67	47 : 205 : 417 : 72	35 : 20=1·75 : 1	52 : 26=2 : 1	0·67 : 1	(courte) : X : 92	
Isfahan Etang (1935)	782	100 : 24=4·17 : 1	62	48 : 210 : 417 : 68	32 : 22=1·45 : 1	43 : 23=1·87 : 1	0·74 : 1	24 : 60 : 45	
Puits.	765	88 : 25=3·52 : 1	58	43 : 202 : 420 : 67	38 : 22=1·73 : 1	52 : 25=2·08 : 1	0·73 : 1	29 : 63 : 50	
Pasghaléh Mare de rivière	760	100 : 23=4·35 : 1	63	45 : 222 : 409 : 67	35 : 22=1·59 : 1	50 : 26=1·92 : 1	0·70 : 1	27 : 62 : 60	

Paracyolops fimbriatus Fischer ♂.

Localité	Longueur µ	Furca	Soie dorsale	Soies apicales	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ép. ap. int.	P. 5 Epine : soie méd. : soie ext.	P. 6 Epine : soie méd. : soie ext.
Dizfoul Mare souterraine.	..	..	..	..	37 : 21=1·76 : 1	52 : 27=1·93 : 1	0·71 : 1	24 : 62 : 64	50 : 33 : 40
Pasghaléh Mare de rivière.	793	77 : 26=2·96 : 1	60	43 : 237 : 454 : 70	38 : 22=1·73 : 1	52 : 27=1·93 : 1	0·73 : 1	23 : 53 : 50	42 : 28 : 47

Paracyclops vagus Lindberg ♀.

Localité	Longueur µ	Furca	Soie dorsale	Soies apicales	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ép. ap. int.	P. 5 Epine : soie méd. : soie ext.	P. 6 Epine : soie méd. : soie ext.
Chahi Mare à végétation abondante.	784	108 : 22=4·90 : 1	57	62 : 200 : 379 : 83	42 : 22=1·90 : 1	70 : 36=1·94 : 1	0·60 : 1	50 : 52 : 83	
Fosse près de la rivière Talar.	760	103 : 22=4·68 : 1	62	57 : 200 : 384 : 67	38 : 22=1·73 : 1	70 : 33=2·12 : 1	0·54 : 1	58 : 55 : 70	
Mare de la rivière Talar.	675	110 : 22=5 : 1	58	55 : 192 : 367 : 68	33 : 21=1·57 : 1	57 : 30=1·90 : 1	0·58 : 1	50 : 67 : 58	
Ramsar Mare près d'un torrent.	884	120 : 23=5·22 : 1	67	59 : 215 : 376 : 83	42 : 23=1·83 : 1	70 : 35=2 : 1	0·60 : 1	57 : 72 : 73	
Sari Rizière.	822	135 : 22=6·14 : 1	55	67 : 219 : 417 : 80	42 : 22=1·90 : 1	77 : 35=2·22 : 1	0·55 : 1	60 : 68 : 93	
Fosse près de la voie ferrée.	822	103 : 21=4·90 : 1	47	57 : 139 : 345 : 72	33 : 18=1·83 : 1	X : 33=X : 1	..	48 : 58 : 80	
Baba Hadji Etang.	665	92 : 22=4·18 : 1	58	57 : 179 : 331 : 67	35 : 18=1·94 : 1	67 : 27=2·45 : 1	0·52 : 1	47 : 43 : 56	
Chouchter Rivière Minaou	855	117 : 23=5·09 : 1	67	57 : 200 : 376 : 73	40 : 22=1·82· 1	68 : 35=1·94 : 1	0·59 : 1	68 : 70 : 75	
	969	113 : 23=4·91 : 1	70	65 : 227 : 417 : 82	42 : 23=1·83 : 1	72 : 38=1·89 : 1	0·56 : 1	63 : 63 : 87	

Paracyclops vagus Lindberg ♂.

Chahi Mare à végétation abondante.	661	83 : 22=3·77 : 1	57	45 : 200 : 354 : 70	35 : 19=1·84 : 1	62 : 27=2·29 : 1	0·56 : 1	37 : 48 : 70	50 : 23 : 75
Sari Rizière . .	741	95 : 23=4·13 : 1	33	60 : 200 : 375 : 53	..	..	..	45 : 50 : 53	63 : 33 : 50
Fosse près de la voie ferrée.	646	78 : 21=3·71 : 1	40	58 : 197 : 367 : 67	35 : 20=1·75 : 1	60 : 33=1·82 : 1	0·55 : 1	50 : X : 62	62 : 32 : 55

Ectocyclops rubescens Brady ♀.

Localité	Longueur µ	Furca	Soie dorsale	Soies apicales	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ep. ap. int.	P 5 Epine : soie méd. : soie ext.	Première antenne. Nombre d'articles.
Chahi. Mare à végétation abondante.	817	80 : 30=2·67 : 1	50	67 : 267 : X : 75	33 : 23=1·43 : 1	79 : 33=2·39 : 1	0·42 : 1	80 : 65 : 67	11
	855	80 : 37=2·16 : 1	80	68 : 245 : 584 : 70	37 : 26=1·42 : 1	57 : 35=2·29 : 1	0·43 : 1	100 : 35 : 70	11
Fosse près de la rivière Talar.	931	67 : 33=2·03 : 1	72	59 : 217 : X : 56	33 : 26=1·27 : 1	70 : 33=2·12 : 1	0·47 : 1	88 : 67 : 53	11
Mare de la rivière Talar.	779	73 : 33=2·21 : 1	53	63 : 217 : 535 : 62	32 : 22=1·45 : 1	77 : 32=2·40 : 1	0·42 : 1	77 : X : 53	11
Ramsar Petit étang.	798	77 : 38=2·03 : 1	70	67 : 217 : 529 : 68	32 : 23=1·39 : 1	73 : 33=2·21 : 1	0·44 : 1	95 : 58 : 67	11
Sari Rizière.	865	83 : 37=2·24 : 1	57	67 : 237 : 576 : 85	35 : 24=1·46 : 1	78 : 35=2·23 : 1	0·45 : 1	92 : 75 : 63	11
Fosse près de la voie ferrée.	851	80 : 33=2·42 : 1	83	63 : 235 : 563 : 67	36 : 25=1·44 : 1	83 : 34=2·44 : 1	0·43 : 1	102 : 75 : 72	11
Chouah (*Suse*) Gare Fosse.	1045	75 : 37=2·08 : 1	75	X : X : X : 62	35 : 27=1·29 : 1	85 : 38=2·24 : 1	0·41 : 1	97 : 75 : 77	11
Village Marécage.	1140	75 : 37=2·03 : 1	67	53 : 254 : 534 : X	37 : 28=1·32 : 1	88 : 37=2·38 : 1	0·42 : 1	103 : 70 : 83	11
	960	63 : 40=1·57 : 1	83	62 : 250 : X : 67	37 : 27=1·37 : 1	X : 38=X : 1	..	100 : 65 : 67	11
Khorab Rivière.	855	83 : 37=2·24 : 1	77	68 : 259 : 608 : 67	36 : 24=1·50 : 1	83 : 41=2·02 : 1	0·43 : 1	97 : 72 : 75	11

Ectocyclops phaleratus Koch ♀.

Baba Hadji Etang.	798	72 : 33=1·89 : 1	72	50 : 200 : 518 : 57	38 : 25=1·52 : 1	70 : 32=2·19 : 1	0·54 : 1	58 : 58 : 50	10
	917	63 : 38=1·66 : 1	70	53 : 224 : X : 60	..	..	..	50 : 50 : 55	10

Ectocyclops rubescens Brady ♂.

Localité	Longueur μ	Furca	Soie dorsale	Soies apicales	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ép. ap. int.	P 5 Epine : soie méd. : soie ext.	P 6 Epine : soie méd : soie ext.
Chahi. Mare à végétation abondante.	665	58 : 32=1·81 : 1	47	58 : 237 : 564 : 63	..	..	..	..	75 : 40 : 47
Fosse prés de la rivière Talar.	651	58 : 28=2·07 : 1	53	52 : 225 : 492 : 53	30 : 22=1·36 : 1	65 : 32=2·03 : 1	0·46 : 1	72 : 45 : 50	72 : 42 : 33
Sari Riziere.	694	63 : 30=2·10 : 1	43	53 : 239 : 513 : 55	20 : 22=1·36 : 1	68 : 27=2·52 : 1	0·44 : 1	73 : 45 : 55	77 : 47 : 42
Fosse près de la voie ferrée.	637	47 : 23=2·04 : 1	..	47 : 207 : X : X	27 : 20=1·35 : 1	58 : 27=2·15 : 1	0·47 : 1	67 : X : 45	68 : 5[illegible] : 33

Ectocyclops phaleratus Koch ♂.

Localité	Longueur μ	Furca	Soie dorsale	Soies apicales	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ép. ap. int.	P 5 Epine : soie méd. : soie ext.	P 6 Epine : soie méd : soie ext.
Baba Hadji Etang.	665	47 : 32=1·47 : 1	42	42 : 192 : 447 : 50	29 : 17=1·70 : 1	55 : 24=2·29 : 1	0·53 : 1	50 : 50 : 47	53 : 25 : 37

Acanthocyclops vernalis Fischer ♀.

Localité	Longueur μ	Furca Long. : Larg.	[illegible]	[illegible]	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int : ép. ap. ext.	[illegible]	P 5 [illegible]	P 5 Art. 2 [illegible]	P 6 [illegible]
Bender Gaz Rivière.	1302	(115+25) : 31=4·[illegible] : 1	67	[illegible]=1·3[illegible] : 1	[illegible]=2·1[illegible] : 1	55 : 57=[illegible] : 1	[illegible] : 77=1·5[illegible] : 1	14	[illegible]	
Lahidjan Fosse.	1112	(100—30) : 25=4·34 : 1	..	[illegible] : 7=2·2[illegible] : 1	7[illegible]=2·[illegible] : 1	45 : 5[illegible]=[illegible] : 1	7[illegible] : 47=[illegible] : 1	.		
	1164	(161—37) : 26=5·31 : 1	47	[illegible]=2·4 : 1	7[illegible]=2·1[illegible] : 1	[illegible] : 45=[illegible] : 1	70 : 28=1·[illegible] : 1	1	[illegible]	
Autre fosse.	1064	(92—30) : 27=4·52 : 1	53	[illegible]=2·[illegible] : 1	[illegible]=2·[illegible] : 1	41 : 42=[illegible] : 1	[illegible] : 42=1·[illegible] : 1	14	27	
Marais.	1235	(95+37) : 28=4·82 : 1	52	[illegible]=2·[illegible] : 1	75 : [illegible]=2·07 : 1	42 : 47=[illegible] : 1	75 : [illegible]=2·[illegible] : 1		.	
Ramsar Mare.	1130	(96—37) : 50=4·43 : 1	7[illegible]	[illegible]=2·[illegible] : 1	72 : [illegible]=2·25 : 1	47 : [illegible]=[illegible]4 : 1	72 : 47=1·[illegible] : 1	15	18	
Recht Fosse.	1254	(110—35) : 25=5·18 : 1	5[illegible]	[illegible]=2·[illegible] : 1	[illegible]=1·[illegible]4 : 1	43 : 47=0·[illegible]1 : 1	[illegible] : 43=1·5[illegible] : 1	20	..	.

Acanthocyclops vernalis Fischer ♂.

Lahidjan Fosse.	912	(71+27) : 25=3·92 : 1	57	85 : 65=1·29 : 1	60 : 30=2 : 1	44 : 45=0·98 : 1	60 : 44=1·36 : 1	..	..	23 : 28
Marais.	893	(73+30) : 23=4·48 : 1	53	85 : X=X : 1	67 : 25=2·68 : 1	53 : 48=1·10 : 1	67 : 53=1·26 : 1	..	..	32 : 35
Recht Fosse.	836	(65+2[illegible]) : 22=4·09 : 1	73	105 : [illegible]=1·[illegible] : 1	57 : 2[illegible]=2·28 : 1	47 : 45=1·04 : 1	57 : 47=1·21 : 1	..	17	30 : 38

Acanthocyclops robustus Sars.

Pahléri-Ghazian										
Puits	♀1400	(114+33) : 33=4·45 : 1	50	1[illegible]7 : [illegible]0=1·31 : 1	[illegible]3 : 37=2·24 : 1	53 : 57=0·93 : 1	1·57	17	22	..
Mare	♀1480	(126+37) : 32=5·09 : 1	72	140 : [illegible]0=1·5[illegible] : 1	[illegible] : 3[illegible]=2·[illegible]7 : 1	52 : 55=0·95 : 1	1·73 : 1	20	20	..
Ramsar Mare	♀1330	(103+37) : 20=7 : 1	58	92 : 80=1·15 : 1	85 : 40=2·12 : 1	50 : 58=0·86 : 1	1·70 : 1	12	27	..
Marécage	♀1370	(91+42) : 33=4·09 : 1	70	97 : 83=1·17 : 1	88 : 35=2·51 : 1	52 : 55=0·95 : 1	1·60 : 1	13	25	..
	♀1160	(92+40) : 30=4·43 : 1	55	95 : 72=1·32 : 1	81 : 38=2·13 : 1	47 : 48=0·98 : 1	1·72 : 1	14	20	..
Pahléri-Ghazian										
Mare	♂969	(82+28) : 26=4·23 : 1	..	102 : 67=1·52 : 1	70 : 20=2·41 : 1	52 : 50=1·04 : 1	1·35 : 1	..	..	28 : 33

Diacyclops bicuspidatus Claus ♀.

Astanéh Bassin	1254	(98+52) : 20=7·5 : 1	53	70 : 58=1·20 : 1	75 : 25=3 : 1	40 : 53=0·75 : 1	1·87 : 1	33	32	..
Babol Puits	1045	(80+50) : 22=5·91 : 1	53	58 : 62=0·94 : 1	68 : 27=2·52 : 1	10 : 52=0·77 : 1	1·70 : 1	..	..	..
Bender Chah										
Mare au bord de la mer	1064	(85+55) : 23=6·09 : 1	..	83 : 53=1·57 : 1	73 : 30=2·43 : 1	43 : 52=0·83 : 1	1·69 : 1	33	23	..
Bender Gaz										
Mare près de la voie ferrée.	1178	(93+57) : 24=6·25 : 1	50	77 : 57=1·35 : 1	73 : 28=2·6 : 1	40 : 50=0·80 : 1	1·82 : 1	37	20	..
Chahi Fosse	1064	(83+50) : 20=6·65 : 1	53	58 : 50=1·16 : 1	65 : 32=2·03 : 1	45 : 53=0·85 : 1	1·44 : 1	33	27	..

Diacyclops bicuspidatus Claus ♀—*contd.*

Localité.	Longueur μ	Furca. Long. : Larg.	Soie dors.	Soie ap. int. : soie ap. ext.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ép. ap. ext.	Enp. 4. Long. art. 3 : ép. ap. int.	P 5. Epine.	P 5. Art. 2. Long.	P 6. Epine : soie méd. : soie ext.
Derbend										
Mare de rivière	1087	(89+53) : 22=6·45 : 1	53	58 : 67=0·81 : 1	67 : 27=2·48 : 1	36 : 50=0·72 : 1	1·86 : 1	32	25	..
Kalatchayéh										
Mare	1026	(97+50) : 20=7·35 : 1	55	72 : 53=1·36 : 1	67 : 26=2·58 : 1	37 : 52=0·71 : 1	1·81 : 1	28	..	..
Lahidjan										
Petite rivière	1283	(94+58) : 24=6·33 : 1	55	73 : 53=1·38 : 1	75 : 27=2·78 : 1	48 : 62=0·77 : 1	1·56 : 1	35	25	..
Fosse	988	(73+47) : 22=5·45 : 1	45	62 : 48=1·29 : 1	57 : 25=2·28 : 1	33 : 47=0·70 : 1	1·73 : 1	25	23	..
Autre fosse	1073	(85+50) : 22=6·14 : 1	52	67 : 53=1·26 : 1	67 : 28=2·39 : 1	42 : 53=0·79 : 1	1·59 : 1	33	22	..
Marais	1045	(73+40) : 20=5·65 : 1	57	60 : 50=1·20 : 1	58 : 25=2·32 : 1	37 : 47=0·79 : 1	1·57 : 1	28	20	..
Puits	1197	(82+30) : 23=4·87 : 1	60	83 : 62=1·34 : 1	58 : 32=1·81 : 1	35 : 42=0·83 : 1	1·66 : 1	16	15	..
Langueroud Puits	941	(63+42) : 20=5·25 : 1	..	62 : 53=1·17 : 1	57 : 25=2·28 : 1	38 : 50=0·76 : 1	1·50 : 1	..	..	..
Qazvin Bassin	1283	(105+67) : 27=6·37 : 1	70	85 : 65=1·29 : 1	83 : 33=2·51 : 1	33 : 58=0·57 : 1	2·51 : 1	37	35	..
Recht										
Bassin	1292	(95+52) : 27=5·44 : 1	67	70 : 53=1·32 : 1	50 : 25=2·55 : 1	42 : 58=0·72 : 1	1·90 : 1	33	23	..
Mare	1055	(90+53) : 22=6·50 : 1	..	67 : 52=1·29 : 1	73 : 26=2·80 : 1	45 : 53=0·90 : 1	1·52 : 1	30	27	..
Puits	1016	(67+63) : 22=5·91 : 1	63	75 : 52=1·44 : 1	63 : 27=2·33 : 1	37 : 47=0·79 : 1	1·70 : 1	33	20	..
Fosse	1035	(73+44) : 23=5·09 : 1	50	67 : 52=1·29 : 1	63 : 27=2·33 : 1	39 : 47=0·83 : 1	1·62 : 1	..	..	..
Pahlévi										
Puits	978	(84+48) : 22=6 : 1	60	70 : 50=1·40 : 1	62 : 23=2·69 : 1	37 : 52=0·71 : 1	1·67 : 1	..	20	..
Pahlévi-Ghazian										
Puits	979	(71+42) : 20=5·65 : 1	58	63 : 50=1·26 : 1	67 : 25=2·65 : 1	33 : 52=0·73 : 1	1·76 : 1	37	25	..

Diacyclops bicuspidatus Claus ♂.

Bender Chah										
Mare au bord de la mer	836	(60+43) : 17=6·06 : 1	..	58 : 42=1·38 : 1	57 : 20=2·85 : 1	33 : 50=0·66 : 1	1·73 : 1	..	..	30 : 27 : 58
Gorgan										
Mare d'une four à briques.	902	(69+43) : 18=6·50 : 1	..	75 : 42=1·79 : 1	57 : 22=2·59 : 1	33 : 50=0·66 : 1	1·73 : 1	..	..	33 : 22 : 58
Pahlévi										
Puits	807	(65+40) : 17=6·18 : 1	57	63 : 53=1·19 : 1	..	..	..	..	..	30 : 20 : 67
Qazvin										
Bassin d'une maison particulière.	936	(83+57) : 20=7 : 1	57	102 : 52=1·96 : 1	65 : 27=2·40 : 1	42 : 55=0·76 : 1	1·55 : 1	..	..	38 : 18 : 58
Bassin d'un caravan-sérail.	1035	(85+57) : 20=7·10 : 1	55	87 : 57=1·53 : 1	70 : 25=2·80 : 1	45 : 60=0·75 : 1	1·56 : 1	..	..	42 : 37 : 62
Ramsar										
Petit étang	874	(62+40) : 17=6 : 1	60	65 : 47=1·38 : 1	55 : 22=2·50 : 1	35 : 50=0·70 : 1	1·57 : 1	..	..	30 : 22 : 63
Recht										
Mare	902	100 : 20=5 : 1	..	..	53 : 23=2·30 : 1	38 : 48=0·79 : 1	1·39 : 1	..	..	33 : 22 : 50

Diacyclops bicuspidatus odessanus Chmankevitch ♀.

Bender Gaz										
Marécage entre la ville et la mer.	1187	(95+55) : 25=6 : 1	52	75 : 53=1·42 : 1	67 : 27=2·48 : 1	45 : 53=0·85 : 1	1·49 : 1	23	14	..
Marais près de la mer	1040	(78+45) : 22=5·59 : 1	..	67 : 50=1·34 : 1	63 : 28=2·25 : 1	35 : 47=0·74 : 1	1·80 : 1	22	16	..
Ahvaz										
Marécage près de la voie ferrée.	1045	(83+50) : 20=6·65 : 1	47	67 : 55=1·22 : 1	63 : 23=2·74 : 1	35 : 43=0·81 : 1	1·80 : 1	23	20	..
Petit étang	1140	(99+58) : 22=7·14 : 1	47	78 : 40=1·95 : 1	65 : 26=2·50 : 1	36 : 45=0·80 : 1	1·80 : 1	28	17	..
Marécage.	1206	(91+63) : 23=6·69 : 1	50	83 : 57=1·46 : 1	75 : 28=2·68 : 1	40 : 50=0·80 : 1	1·87 : 1	22	..	..

Diacyclops bicuspidatus odessanus Chmankevitch ♀—*contd.*

Localité.	Longueur μ.	Furca. Long. : Larg.	Soie dors.	Soie ap. int. : soie ap. ext.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Long. : large.	Enp. 4. Long. art. 3 : ép. ap. int.	P 5. Epine.	P 5. Art. 2. Long.	P 6. Epine : soie méd. : Soie ext.
Bouchir Fosse près de la route de Tchaghadak.	1045	(85+68) : 20=7·65 : 1	42	75 : 53=1·42 : 1	58 : 29=2 : 1	36 : 45=0·80 : 1	1·61 : 1	..	..	..
Darquoin Fosse	1254	(101+78) : 23=7·78 : 1	50	57 : 50=1·74 : 1	75 : 30=2·50 : 1	38 : 50=0·76 : 1	1·97 : 1	30	23	..
Khorramchahr										
Petit marécage	1206	(117+67) : 25=7·36 : 1	47	78 : 50=1·56 : 1	75 : 32=2·34 : 1	42 : 53=0·79 : 1	1·79 : 1	35	20	..
Petite mare	1278	(105+68) : 25=6·92 : 1	63	102 : 57=1·79 : 1	82 : 32=2·56 : 1	42 : 53=0·79 : 1	1·95 : 1	33	13	..
Marghazar Fosse	1064	(93+57) : 21=7·14 : 1	57	77 : 50=1·54 : 1	67 : 26=2·58 : 1	36 : 45=0·80 : 1	1·86 : 1	27	18	..
Tchaghadak Fosse	1349	(109+75) : 23=8 : 1	60	78 : 53=1·47 : 1	70 : 28=2·50 : 1	42 : 48=0·87 : 1	1·67 : 1	25	23	..

Diacyclops bicuspidatus odessanus Chmankevitch ♂.

Localité.	Longueur μ.	Furca. Long. : Larg.	Soie dors.	Soie ap. int. : soie ap. ext.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Long. : large.	Enp. 4. Long. art. 3 : ép. ap. int.	P 5. Epine.	P 5. Art. 2. Long.	P 6. Epine : soie méd. : Soie ext.
Bender Gaz										
Marécage entre la ville et la mer.	860	(65+35) : 19=5·26 : 1	47	87 : 45=1·93 : 1	63 : 22=2·86 : 1	33 : 50=0·66 : 1	1·90 : 1	..	..	27 : 33 : 62
Ahwaz Marécage près de la voie ferrée	784	(72+45) : 17=6·88 : 1	..	67 : 43=1·56 : 1	[illegible] : 20=3 : 1	32 : 43=0·74 : 1	1·67 : 1	..	..	33 : 17 : 55
Autre marécage	855	(69+48) : 17=6·88 : 1	48	53 : 42=1·[illegible] : 1	[illegible] : 20=3 : 1	33 : 45=0·60 : 1	1·52 : 1	..	..	33 : 33 : 75
Behbéhan Puits	902	(74+43) : 16=7·31 : 1	50	55 : 45=1·[illegible] : 1	57 : 20=2·[illegible] : 1	35 : 45=0·73 : 1	1·63 : 1	..	..	36 : 33 : 50
Khorramchahr										
Petite mare	846	(75+45) : 18=6·83 : 1	53	[illegible]3 : 47=1·77 : 1	57 : 23=2·45 : 1	37 : 57=0·65 : 1	1·54 : 1	..	..	42 : 30 : 57
Tchaghadak Fosse	936	(60+45) : 17=6·15 : 1	48	77 : 47=1·64 : 1	73 : 22=2·40 : 1	35 : 42=0·83 : 1	1·51 : 1	..	..	33 : 23 : 58

Diacyclops bisetosus Rehberg ♀.

Bender Gaz										
Mare près de la voie ferrée.	1074	(93—33) : 23=5·74 : 1	55	50 : 67=0·75 : 1	43 : 30=1·43 : 1	50 : 33=1·52 : 1	[illegible]·86 : 1	23	17	..
Chahi										
Fosse	1150	(9[illegible]—27) : 20=5·[illegible]5 : 1	67	42 : 57=[illegible]·74 : 1	40 : 27=1·48 : 1	47 : 32=1·47 : 1	0·85 : 1	25	15	..
	965	(88—27) : 20=5·75 : 1	70	50 : 77=[illegible] : 1	41 : 27=1·52 : 1	53 : 33=1·60 : 1	0·77 : 1	30	19	..
	902	(95—25) : 22=5·45 : 1	53	50 : [illegible] : 1	[illegible] : 26=1.46 : 1	47 : 28=1·[illegible] : 1	0·81 : 1	18	17	..
Gorgan										
Fosse	993	(52—25) : 22=4·86 : 1	59	42 : [illegible]=[illegible]·84 : 1	38 : 27=1·41 : 1	45 : 27=1·67 : 1	0·84 : 1	17	15	..
Kalatchayéh										
Petit étang	1064	(107—39) : 23=5·9[illegible] : 1	67	[illegible]3 : 70=[illegible] : 1	45 : 30=1·50 : 1	50 : 37=1·35 : 1	0·90 : 1	..	..	..
Lahidjan										
Mare	846	(80+23) : 19=5·42 : 1	..	50 : 57=0·88 : 1	37 : 28=1·32 : 1	43 : 28=1·53 : 1	0·56 : 1	..	..	..
Pahlévi										
Lagune	883	(80+20) : 23=4·35 : 1	67	67 : 55=1·16 : 1	38 : 27=1·41 : 1	37 : 30=1·23 : 1	1·03 : 1	22	15	..
	903	(86+27) : 23=4·91 : 1	53	50 : 58=0·86 : 1	40 : 26=1·54 : 1	45 : 33=1·36 : 1	0·89 : 1	27	17	..
	1007	(93+25) : 23=5·13 : 1	73	55 : 53=0·92 : 1	42 : 29=1·45 : 1	48 : 30=1·60 : 1	0·87 : 1	21	15	..
Mare	950	(83+25) : 22=4·90 : 1	58	50 : 53=0·94 : 1	37 : 27=1·37 : 1	43 : 25=1·72 : 1	0·86 : 1	17	13	..
	1026	(83+25) : 19=5·68 : 1	58	45 : 52=0·87 : 1	36 : 27=1·33 : 1	43 : 28=1·53 : 1	0·84 : 1	13	14	..
Autre mare	912	(75+22) : 20=4·85 : 1	55	38 : 47=0·81 : 1	33 : 25=1·32 : 1	43 : 25=1·72 : 1	0·77 : 1	25	12·5	..
Pahlévi-Ghazian										
Mare	1102	(103+27) : 25=5·20 : 1	65	67 : 70=0·96 : 1	50 : 32=1·56 : 1	58 : 37=1·57 : 1	0·86 : 1	20	18	..

Diacyclops bisetosus Rehberg ♀.—*contd.*

Localité.	Longueur μ	Furca. Long. : Larg.	Soie dors.	Soie ap. int. : soie ap. ext.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ep. ap. ext.	Enp. 4. Long. art. 3 : ep. ap. int.	P 5. Epine.	P 5. Art. 2. Long.	P 6. Epine : soie méd : soie ext.
Ramsar										
Mare d'un torrent	988	(87+28) : 25=4·60 : 1	57	50 : 58=0·86 : 1	40 : 30=1·33 : 1	52 : 37=1·40 : 1	0·77 : 1·	..	..	..
Trou d'eau	959	(96+27) : 22=5·59 : 1	67	62 : 70=0·89 : 1	42 : 28=1·50 : 1	50 : 33=1·52 : 1	0·84 : 1	25	20	..
	955	(95+30) : 25=5 : 1	58	68 : 72=0·94 : 1	43 : 28=1·53 : 1	50 : 33=1·52 : 1	0·86 : 1	18	17	..
Petit étang	874	(88+25) : 20=5·65 : 1	62	45 : 58=0·78 : 1	38 : 27=1·41 : 1	47 : 32=1·47 : 1	0·81 : 1	17	15	..
	950	(87+30) : 23=5·09 : 1	72	50 : 63=0·79 : 1	37 : 27=1·37 : 1	47 : 35=1·34 : 1	0·79 : 1	22	15	..
	997	(102+28) : 25=5·20 : 1	70	63 : 72=0·87 : 1	42 : 30=1·40 : 1	55 : 33=1·67 : 1	0·70 : 1	23	17	..
Mare	855	(70+25) : 21=4·52 : 1	55	55 : 60=0·92 : 1	37 : 26=1·42 : 1	43 : 30=1·43 : 1	0·86 : 1	20	15	..
Marécage	921	(86+27) : 23=4·91 : 1	56	50 : 53=0·94 : 1	42: 27=1·56 : 1	50 : 33=1·52 : 1	0·84 : 1	27	18	..
Ahvaz										
Etang d'eau saumâtre	1197	(108+47) : 22=6·82 : 1	67	60 : 57=1·05 : 1	48 : 32=1·50 : 1	60 : 45=1·33 : 1	0·80 : 1	25	22	..
Khorramchahr										
Bras-mort de canal d' irrigation.	1178	(134+38) : 22=7·82 : 1	67	83 : 75=1·10 : 1	55 : 32=1·72 : 1	63 : 45=1·62 : 1	0·57 : 1	..	..	..
Tchabadi										
Marais	1187	(85+40) : 30=4·17 : 1	75	92 : 88=1·05 : 1	53 : 25=2·12 : 1	52 : 30=1·73 : 1	1·02 : 1	50	..	..

Diacyclops bisetosus Rehberg ♂.

Localité.	Longueur μ	Furca. Long. : Larg.	Soie dors.	Soie ap. int. : soie ap. ext.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. ap. int. : ep. ap. ext.	Enp. 4. Long. art. 3 : ep. ap. int.	P 5. Epine.	P 5. Art. 2. Long.	P 6. Epine : soie méd : soie ext.
Gorgan										
Petite mare	617	(67+20) : 18=4·83 : 1	42	33 : 37=[illegible] : 1	33 : 22=1·50 : 1	43 : 23=1·87 : 1	0·77 : 1	..	..	20 : 15 : 42
Fosse	855	(72—25) : 18=5·39 : 1	50	37 : 42=[illegible] : 1	37 : 25=1·4[illegible] : 1	50 : 30=1·67 : 1	0·74 : 1	..	..	20 : 25 : 40
Lahidjan										
Rizière	779	(74—15) : 18=5·11 : 1	50	47 : 5[illegible]=[illegible] : 1	38 : 25=1·52 : 1	47 : 30=1·57 : 1	0·81 : 1	..	..	17 : 27 : 50

PREOCCUPIED NAMES IN THE OLIGOCHAETA.

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Family Ocnerodrilidae.

Genus **Curgiona,** nom. nov.

1921. *Curgia,* Michaelsen, *Mitt. Mus. Hamburg* XXXVIII, p. 59. Genotype *Curgia narayani* Michaelsen 1921. (*Non Curgia* Walker 1860, Trichoptera. *Non Curgia* Walker 1864, Lepidoptera.).

Genus **Quechuona,** nom. nov.

1923. *Quechua,* Michaelsen, *Med. Goteborgs Mus. Zool.* XXXII, p. 6. Genotype *Quechua rosea* Michaelsen 1923. (*Non Quechua* Strebel 1910, Mollusca.).

Family Eudrilidae.

Subfamily *EUDRILINAE.*

Genus **Bettoniella,** nom. nov.

1903. *Bettonia,* Beddard, *Proc. Zool. Soc. London,* 1903, p. 213. Genotype *Bettonia lagariensis* Beddard 1903. (*Non Bettonia* Butler 1898, Lepidoptera.).

Family Megascolecidae.

Genus **Pheretima** Kinberg 1857.

Pheretima honbaensis, nom. nov.

1931. *Pheretima (Pheretima) hetrola* Michaelsen, *Arch. Zool. Exp.* LXXVI, p. 520. Type locality Berg Hon Ba, South Annam. (Preoccupied by *Pheretima hetrola* Ude 1905, type locality Ralum, New Pommerania.).

Embrik Strand, in his note entitled Miscellanea nomenclatorica zoologica et palaeontologica. I. (*Arch. Naturgesch* Bd. 92, Abt. A, Heft 8, p. 36, July 1928). has renamed *Bohemilla* Vejdovsky 1883 (*non Bohemilla* Barrande 1872) *Bohemillula* Strand. In 1903 Michaelsen renamed the genus *Vejdovskyella* (*Mitt. Mus. Hamburg* XIX, p. 185). Michaelsen's name is valid.

Attention of Strand and others is directed to the fact that *Holoscolex* Ude 1905 (*non Holoscolex* Cognetti 1901, Glossoscolecidae) is now known as *Udeina.*

The author's thanks are extended to Dr. Waldo Schmitt and to Dr. Grace Pickford for securing information from journals that are not available locally.

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LIST OF AUTHORS.

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[*N.B.*—An asterisk (*) preceding a name denotes a new variety or sub-species; a dagger (†) indicates a new species; a double dagger (‡) a new genus or sub-genus; a double asterisk (**) a new family or sub-family; synonyms are printed in italics.]

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